

# EXHIBIT 1

**IN THE UNITED STATES DISTRICT COURT  
FOR THE EASTERN DISTRICT OF TEXAS  
MARSHALL DIVISION**

TELECOM NETWORK SOLUTIONS, LLC,	§	
	§	
<i>Plaintiff,</i>	§	
	§	
v.	§	Case No. 2:21-cv-00415-JRG
	§	(Lead Case)
	§	
AT&T CORP., AT&T COMMUNICATIONS LLC,	§	
AT&T MOBILITY LLC, AT&T MOBILITY II	§	JURY TRIAL DEMANDED
LLC, and AT&T SERVICES INC.	§	
	§	
<i>Defendants.</i>	§	

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TELECOM NETWORK SOLUTIONS, LLC,	§	
	§	
<i>Plaintiff,</i>	§	
	§	
v.	§	Case No. 2:21-cv-00416-JRG
	§	(Member Case)
	§	
VERIZON COMMUNICATIONS, INC., et al	§	
	§	
<i>Defendants.</i>	§	
	§	
	§	

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TELECOM NETWORK SOLUTIONS, LLC,	§	
	§	
<i>Plaintiff,</i>	§	
	§	
v.	§	Case No. 2:21-cv-00418-JRG
	§	(Member Case)
	§	
T-MOBILE USA, INC., et al	§	
	§	
<i>Defendants.</i>	§	
	§	
	§	

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**PLAINTIFF'S DISCLOSURE OF ASSERTED CLAIMS AND INFRINGEMENT  
CONTENTIONS AND DOCUMENT PRODUCTION ACCOMPANYING DISCLOSURE  
PURSUANT TO P.R. 3-1 & 3-2**

Pursuant to Patent Rules 3-1 and 3-2, Plaintiff Telecom Network Solutions, LLC (“TNS” or “Plaintiff”) hereby provides its Disclosure of Asserted Claims and Infringement Contentions and its Document Production Accompanying Disclosure against Defendants AT&T Corp., AT&T Communications LLC, AT&T Mobility LLC, AT&T Mobility II LLC, and AT&T Services Inc. (“AT&T” or “Defendants”).

Plaintiff presents these Infringement Contentions based on Plaintiff’s analysis of the facts currently known based on Plaintiff’s review of certain publicly available information. Plaintiff reserves the right to amend or further supplement these disclosures—including to supplement its infringement contentions pursuant to P.R. 3-6—with additional information learned in the course of discovery or further investigation concerning Defendants’ products or services.

**I. TNS’ P.R. 3-1 Disclosures**

**A. P.R. 3-1(a): Infringed Claims**

Subject to ongoing discovery and investigation, TNS asserts that Defendants infringe claims 1-2, 4-11, 13-15, 17-21, 23, 25-29, and 31-42 (collectively, “Asserted Claims”) of U.S. Patent No. RE47,813 (the “‘813 Patent”) directly under 35 U.S.C. § 271(a) by making, using, offering to sell and/or selling the Accused Instrumentalities set forth in Part I.B below.

TNS reserves the right to supplement its position as to infringement following further discovery and/or claim construction.

**B. P.R. 3-1(b): Accused Instrumentalities**

Subject to ongoing discovery and investigation, and based on present information and belief, Plaintiff contends that the Asserted Claims are infringed by Defendants’ products and services identified in the chart attached hereto as Exhibit A (“Accused Instrumentalities”) including but not limited to the system components implementing a dynamic allocation of network resources in Defendants’ 3G, 4G, 4G LTE, and 5G networks.

Plaintiff reserves the right to supplement its infringement contentions to identify additional products and/or services, if necessary, when it is provided with non-public documents and/or source code from third parties and/or the Defendants via the discovery process.

**C. P.R. 3-1(c): Preliminary Infringement Charts**

Subject to ongoing discovery and investigation, and based on present information and belief, Plaintiff contends that each element of each infringed claim is found within each Accused Instrumentality as shown in the preliminary infringement chart attached hereto as **Exhibit A** and incorporated herein in its entirety. Plaintiff's identification in the claim charts is exemplary and based upon public information currently available to Plaintiff. The accompanying document production may be found at TNS10000001-186.

Plaintiff reserves the right to amend its asserted claims and infringement contentions pursuant to P.E. 3-6 as discovery progresses and additional information is gathered.

**D. P.R. 3-1(d): Literal Infringement and Infringement Under the Doctrine of Equivalents**

Subject to ongoing discovery and investigation, and based on available information obtained to date, Plaintiff hereby contends that each element of each asserted claim is literally present in each of the Accused Instrumentalities as specifically shown in Exhibit A unless otherwise stated in that exhibit. As indicated above, discovery is necessary to further develop Plaintiff's infringement positions—either literal or under the Doctrine of Equivalents—and the Court has yet to issue a claim construction order. Pursuant to P.R. 3-6, Plaintiff expressly reserves the right to amend and supplement its position on whether there is infringement under the Doctrine of Equivalents of any element of any asserted claim after further discovery from the Defendants (and/or third parties) and/or pending this Court's claim construction order.

**E. P.R. 3-1(e): Priority Dates**

The '813 Patent is a Reissue Patent of U.S. Patent No. 8,600,850. The Reissue application was filed on August 1, 2018. The '813 Patent is entitled to priority to at least the following applications: U.S. Patent Application No. 13/515,101, now U.S. Patent No. 8,600,850, filed on August 13, 2012, which is a National Stage entry of PCT/CA2009/001809, filed December 10, 2009.

**F. P.R. 3-1(f): Right to Rely on Plaintiff's Own Instrumentality**

TNS does not contend that it practices the asserted claims of the '813 Patent.

**II. Document Production Accompanying Disclosure**

**A. Documents Responsive to P.R. 3-2(a)**

Plaintiff does not presently possess any relevant, non-privileged documents responsive to P.R. 3-2(a). Plaintiff will supplement this response should any relevant, non-privileged documents be identified in the future.

**B. Documents Responsive to P.R. 3-2(b)**

Plaintiff does not presently possess any relevant, non-privileged documents responsive to P.R. 3-2(b). Plaintiff will supplement this response should any relevant, non-privileged documents be identified in the future.

**C. Documents Responsive to P.R. 3-2(c)**

Pursuant to P.R. 3-2(c), a copy of the file history of the '813 Patent has been produced under Bates Numbers TNS-FH00000001-950.

**III. CONCLUSION**

The information contained in these disclosures is based on Plaintiff's analysis of the facts currently known to it based on Plaintiff's review of public information reasonably available to it.

Additional pertinent information about Defendants' Accused Instrumentalities is not available without engaging in further discovery. Thus, Plaintiff reserves the right to supplement, modify, and/or amend these disclosures as new information becomes available, and discovery progresses. Plaintiff anticipates that additional facts and relevant documents will be uncovered that will warrant supplementing and/or amending these disclosures.

DATED: March 2, 2022

Respectfully submitted,

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**ATTORNEYS FOR PLAINTIFF  
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**CERTIFICATE OF SERVICE**

I hereby certify that a true and correct copy of the above and foregoing document has been served on all counsel of record by email on March 2, 2022.

/s/ Blaine Larson  
Blaine Larson

**U.S. Patent No. USRE47813 (8,600,850) v. AT&T**

**Filed:** '813 filed August 1, 2018 ('850 original 371(c) date August 13, 2012)

**Priority Date:** December 10, 2009 (via Canadian PCT)

**Issue Date:** January 14, 2020 ('850 original issued December 3, 2013)

These infringement contentions incorporate by reference the discussion and materials cited in the *Telecom Network Solutions vs. AT&T Inc., et. al.* Complaint filed November 9, 2021.

CLAIM 1	'813 PATENT V. AT&T
<p><b>1[A].</b> A method for dynamic allocation of network resources comprising:</p>	<p>AT&amp;T provides network services to customers and, in doing so, implements a method for dynamic allocation of network resources.</p> <p>AT&amp;T operates and sells access to its cellular communication network that provides cellular and data services to its customers via cellular base stations (also referred to at times as cell towers) located throughout the United States, and thereby directly infringes this method claim. These base stations communicate with customers' mobile cellular devices (including mobile phones, tablets, laptops and mobile hotspots) in accordance with 3G, 4G, 4G LTE and 5G mobile network standards. AT&amp;T also sells mobile devices through its distribution channels designed to communicate with the AT&amp;T Network in accordance with the aforementioned mobile network standards. <i>See e.g.</i> <a href="https://www.att.com/5g/coverage-map/">https://www.att.com/5g/coverage-map/</a> (last visited January 18, 2022); <a href="https://www.att.com/offers/network/">https://www.att.com/offers/network/</a> (last visited January 18, 2022); <a href="https://www.att.com/5g/consumer/">https://www.att.com/5g/consumer/</a> (last visited January 18, 2022).</p> <p>AT&amp;T's Broadband Internet Access Services provides a method for dynamic allocating network resources. <a href="https://about.att.com/sites/broadband">https://about.att.com/sites/broadband</a> (last visited January 18, 2022). AT&amp;T's website "describes the mass market wireless and wired broadband internet access services we offer. In this document, we provide information about the network practices, performance characteristics, and commercial terms applicable to our mass market wired, mobile and Wi-Fi broadband internet access services." <a href="https://about.att.com/sites/broadband">https://about.att.com/sites/broadband</a> (last visited January 18, 2022).</p> <p>AT&amp;T also defines its Terms and Conditions. <i>See</i> <a href="https://www.att.com/legal/terms.consumerServiceAgreement.html">https://www.att.com/legal/terms.consumerServiceAgreement.html</a> (last visited January 18, 2022).</p> <p>AT&amp;T offers numerous Rate Plans and Data Plans. <i>See, e.g.</i> <a href="https://www.att.com/plans/wireless/">https://www.att.com/plans/wireless/</a>. While those Plans have varied over time and form part of these contentions, the current AT&amp;T Plans for phones are representative. Those current plans include 4GB Plan, Unlimited Starter Plan, Unlimited Extra Plan, and Unlimited Elite Plan. Other than Unlimited Elite, most of those plans include data volume caps, after which the customer is subject to having their data speeds reduced to a lower bit rate. For example, the Unlimited Extra plan has a Premium Data cap of 50 GB per month. <a href="https://www.att.com/plans/wireless/">https://www.att.com/plans/wireless/</a>. AT&amp;T also offers prepaid plans, which depending on the Service Plan selected may include Premium Data caps. <a href="https://www.att.com/buy/wireless/prepaid/plan">https://www.att.com/buy/wireless/prepaid/plan</a>. For</p>

example, the Prepaid Unlimited Plus plan has a monthly data cap of 22GB, after which the customer is subject to having their data speeds reduced to a lower bit rate. <https://www.att.com/prepaid/>.

As noted below, a substantial percentage of AT&T customers may experience a lower prioritization relative to the more expensive plans offered by AT&T. This lower prioritization may occur because a customer has exceeded its monthly data volume cap, or because the customer's plan and rate is itself assigned a lower priority than other more costly Service Plans. The net result is that these lower-priority customers are subjected to having their data rates reduced and in at least some instances, being subject to a lower bit-rate cap than other customers assigned higher priority by AT&T, especially during periods and locations where the network is congested with demand exceeding network capacity. Further discovery will be necessary to determine the exact manner in which this method is actually implemented within the AT&T network, but the publicly available makes it evident that AT&T is performing the method in the manner set forth in the asserted claims. All AT&T Rate Plans that dynamically modify a particular customer's data rates relative to other customers based upon either exceeding a data volume cap and/or having elected a less costly Rate Plan that provides lower bit-rate caps relative to other higher priority during periods of network congestion form part of the infringing activities of AT&T.

AT&T explains that its network is a shared network among multiple subscribers:

- "In addition, like the other networks that make up the internet, *the AT&T network is a shared network*, which means that the transmission links and other network resources used to provide broadband services are shared among AT&T's subscribers, as well as among the various services offered by AT&T. Temporary congestion may occur when a large number of customers in a concentrated area access the network at the same time or when some customers consume a very large amount of network capacity during busy periods, such as at stadium events, during peak usage times, or during planned network maintenance." (<https://about.att.com/sites/broadband/network>)

AT&T identifies a "cell site" as a shared network resource. AT&T explains that cell sites are shared by multiple devices:

- "Customers subject to Congestion-based Data Management will experience reduced speeds and increased latency only when they use data at a *cell site experiencing network congestion at the same moment*. As soon as the congestion at the cell site abates, or if the customer's session

	<p>migrates to an uncongested cell site, speeds and latency are not affected.”  <a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</p> <p>AT&amp;T implements various “Congestion-based Data Management” techniques to manage the allocation of network resources. AT&amp;T explains that “this network management practice adjusts dynamically to address the amount of congestion.”</p> <ul style="list-style-type: none"> <li>• In addition, <i>this network management practice adjusts dynamically to address the amount of congestion</i>, which can start and stop over a very short time period (often measured in fractions of a second), further minimizing any customer impact. Because the amount of congestion at a cell site can vary significantly, the performance impact for affected AT&amp;T Unlimited Data Plan customers may also vary significantly, but such impact will last only as long as the site is congested. <a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> </ul> <p>AT&amp;T explains that when “a lot of devices are using mobile data at once, it can put a strain on our network,” and “we may have to slow your data speed to keep everyone connected.”</p> <ul style="list-style-type: none"> <li>• “If a lot of devices are using mobile data at once, it can put a strain in our network. <i>This is called network congestion, and we may have to slow your data speed to keep everyone connected.</i> On an unlimited plan? We may temporarily slow your speed at any time if our network is busy. We may also slow it after you use more than 50GB or 22GB of data in a single bill period.”  <a href="https://www.att.com/help/wireless/data-usage/">https://www.att.com/help/wireless/data-usage/</a>)</li> </ul> <p>AT&amp;T’s network management takes into account the customer’s billing profile and the localized demand for a particular network resource:</p> <ul style="list-style-type: none"> <li>• “Congestion-based Data Management. One network management practice we use to manage our wireless network resources <i>may affect customers with most AT&amp;T post-paid and AT&amp;T PREPAID<sup>SM</sup> unlimited mobile data plans (“AT&amp;T Unlimited Data Plans”).</i> During periods of congestion, these customers may experience reduced data speeds and increased latency as <i>compared to other customers using the same cell site</i> (“Congestion-based Data Management”). <i>Depending on the customer’s AT&amp;T Unlimited Data Plan, they will either always experience</i></li> </ul>
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*Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan* (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans.” (<https://about.att.com/sites/broadband/network>)

The 3GPP Standards<sup>1</sup> describe the use of certain mobile network elements, such as the Policy and Control Rules Function (PCRF), that support implementing a method for dynamic allocation of network resources. For example, the 3GPP Standards describe the use of a Policy and Charging Control (PCC) architecture to implement policy decisions between a 3GPP access UE and a cellular provider’s IP services network.

## 1 Scope

The present document specifies the overall stage 2 level functionality for Policy and Charging Control that encompasses the following high level functions for IP-CANs (e.g. GPRS, Fixed Broadband, EPC, etc.):

- Flow Based Charging for network usage, including charging control and online credit control, for service data flows and application traffic;
- Policy control (e.g. gating control, QoS control, QoS signalling, etc.).

The present document specifies the Policy and Charging Control functionality for Evolved 3GPP Packet Switched domain, including both 3GPP accesses GERAN/UTRAN/E-UTRAN and Non-3GPP accesses, according to TS 23.401 [17] and TS 23.402 [18].

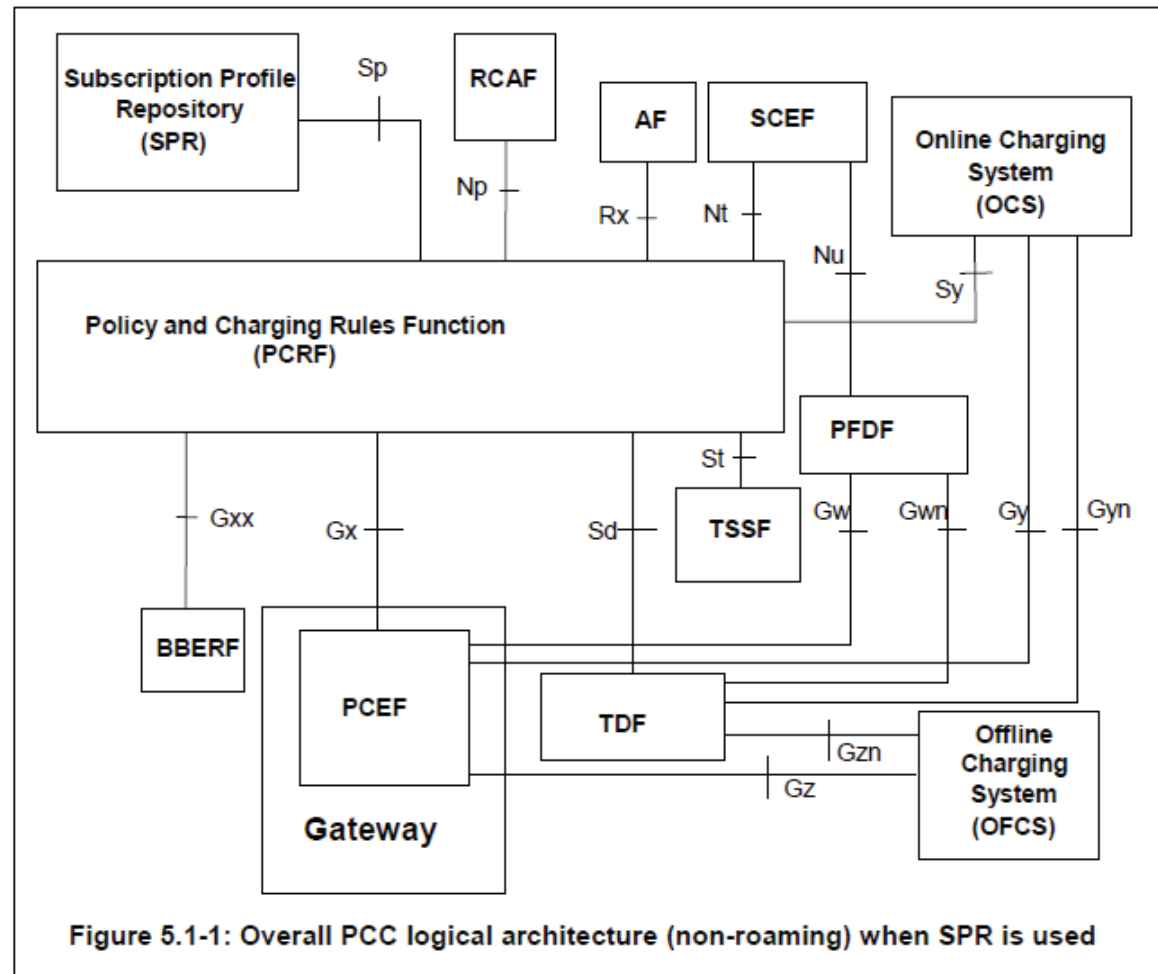
3GPP TS 23.203 at 14.

<sup>1</sup> Unless stated otherwise, the “3GPP Standards” document citations/excerpts herein refer to 3GPP TS 23.203 (ETSI TS 123.203), Version 16.2.0, Release 16 (2020-11), 3GPP TS 23.401 (ETSI TS 123.401), Version 16.11.0, Release 16 (2021-09), 3GPP TS 23.503 (ETSI TS 123.503), Version 16.5.0, Release 16 (2020-09).

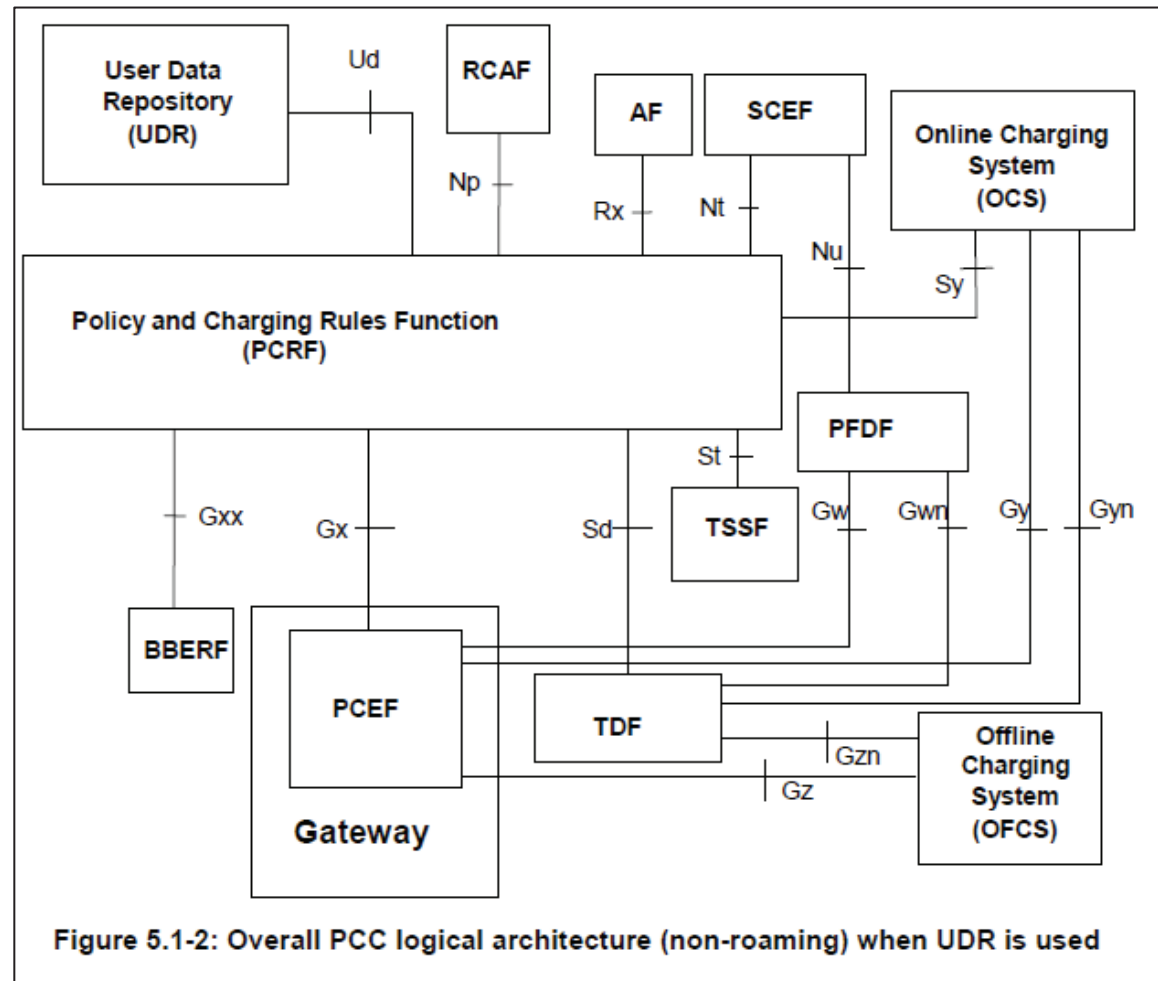
**IP-CAN session:** The association between a UE and an IP network. The association is identified by one IPv4 and/or an IPv6 prefix together with UE identity information, if available, and a PDN represented by a PDN ID (e.g. an APN). An IP-CAN session incorporates one or more IP-CAN bearers. Support for multiple IP-CAN bearers per IP-CAN session is IP-CAN specific. An IP-CAN session exists as long as UE IP addresses/prefix are established and announced to the IP network.

3GPP TS 23.203 at 17.

The following figures illustrate logical architectures for implementing PCC:



3GPP TS 23.203 at 28 (PCC logical architecture with Subscription Profile Repository).



3GPP TS 23.203 at 29 (PCC logical architecture when User Data Repository is used); *see also id.* at 29-30 (illustrating similar architectures that support roaming).

The PCRF is described below:

## 6.2.1 Policy Control and Charging Rules Function (PCRF)

### 6.2.1.0 General

The PCRF encompasses policy control decision and flow based charging control functionalities.

The PCRF provides network control regarding the service data flow detection, gating, QoS and flow based charging (except credit management) towards the PCEF and/or TDF.

The PCRF provides network control regarding the application detection, gating, QoS and application based charging (except credit management) towards the TDF and the PCEF enhanced with ADC.

The PCRF shall apply the security procedures, as required by the operator, before accepting service information from the AF.

The PCRF shall decide whether application traffic detection is applicable, as per operator policies, based on user profile configuration, received within subscription information.

The PCRF shall decide how certain service/application traffic shall be treated in the PCEF and in the TDF, if applicable, and ensure that the PCEF user plane traffic mapping and treatment is in accordance with the user's subscription profile.

3GPP TS 23.203 at 71.

The PCRF also uses PCC rules to implement its policies, and some of these rules are dynamically modified.

## 6.3 Policy and charging control rule

### 6.3.1 General

The Policy and charging control rule (PCC rule) comprises the information that is required to enable the user plane detection of, the policy control and proper charging for a service data flow. The packets detected by applying the service data flow template of a PCC rule form a service data flow.

Two different types of PCC rules exist: Dynamic rules and predefined rules. The dynamic PCC rules are provisioned by the PCRF via the Gx reference point, while the predefined PCC rules are directly provisioned into the PCEF and only referenced by the PCRF. The usage of predefined PCC rules for QoS control is possible if the BBF remains in the PCEF during the lifetime of an IP-CAN session. In addition, predefined PCC rules may be used in a non-roaming situation and if it can be guaranteed that corresponding predefined QoS rules are configured in the BBF and activated along with the predefined PCC rules.

NOTE 1: The procedure for provisioning predefined PCC rules is out of scope for this specification.

NOTE 2: There may be another type of predefined rules that are not explicitly known in the PCRF and not under the control of the PCRF. The operator may define such predefined PCC rules, to be activated by the PCEF on one IP-CAN bearer within the IP-CAN session. The PCEF may only activate such predefined PCC rules if there is no UE provided traffic mapping information related to that IP-CAN bearer. The IP-CAN session termination procedure deactivates such predefined PCC rules.

There are defined procedures for activation, modification and deactivation of PCC rules (as described in clause 6.3.2). The PCRF may activate, modify and deactivate a PCC rule at any time, over the Gx reference point. However, the modification procedure is applicable to dynamic PCC rules only.

3GPP TS 23.203 at 99.

The PCRF “uses usage monitoring for making dynamic policy decisions”:

#### 4.4 Usage Monitoring Control

It shall be possible to apply usage monitoring for the accumulated usage of network resources on a per IP-CAN session and user basis. This capability is required for enforcing dynamic policy decisions based on the total network usage in real-time.

The PCRF that uses usage monitoring for making dynamic policy decisions shall set and send the applicable thresholds to the PCEF or TDF for monitoring. The usage monitoring thresholds shall be based either on time, or on volume. The PCRF may send both thresholds to the PCEF or TDF. The PCEF or TDF shall notify the PCRF when a threshold is reached and report the accumulated usage since the last report for usage monitoring. If both time and volume thresholds were provided to the PCEF or TDF, the accumulated usage since last report shall be reported when either the time or the volume thresholds are reached.

NOTE: There are reasons other than reaching a threshold that may cause the PCEF/TDF to report accumulated usage to the PCRF as defined in clauses 6.2.2.3 and 6.6.2.

The usage monitoring capability shall be possible for an individual or a group of service data flow(s), or for all traffic of an IP-CAN session in the PCEF. When usage monitoring for all traffic of an IP-CAN session is enabled, it shall be possible to exclude an individual SDF or a group of service data flow(s) from the usage monitoring for all traffic of this IP-CAN session. It shall be possible to activate usage monitoring both to service data flows associated with predefined PCC rules and dynamic PCC rules, including rules with deferred activation and/or deactivation times while those rules are active.

3GPP TS 23.203 at 25. The PCRF gathers information from other sources as well to support its implementation of policy within the network:

### 5.2.2 Gx reference point

The Gx reference point resides between the PCEF and the PCRF.

The Gx reference point enables the PCRF to have dynamic control over the PCC behaviour at a PCEF.

The Gx reference point enables the signalling of PCC decision, which governs the PCC behaviour, and it supports the following functions:

- Establishment of Gx session (corresponding to an IP-CAN session) by the PCEF;
- Request for PCC decision from the PCEF to the PCRF;
- Provision of IP flow mobility routing information from PCEF to PCRF; this applies only when IP flow mobility as defined in TS 23.261 [23] is supported;
- Provision of PCC decision from the PCRF to the PCEF;
- Reporting of the start and the stop of detected applications and transfer of service data flow descriptions and application instance identifiers for detected applications from the PCEF to the PCRF;
- Reporting of the accumulated usage of network resources on a per IP-CAN session basis from the PCEF to the PCRF;
- Delivery of IP-CAN session specific parameters from the PCEF to the PCRF or, if Gxx is deployed, from the PCRF to the PCEF per corresponding request;
- Negotiation of IP-CAN bearer establishment mode (UE-only or UE/NW);
- Termination of Gx session (corresponding to an IP-CAN session) by the PCEF or the PCRF.

3GPP TS 23.203 at 31.

### 5.2.12 Np reference point

The Np reference point resides between the RCAF and the PCRF.

The Np reference point enables transport of RAN User Plane Congestion Information (RUCI) sent from the RCAF to the PCRF for all or selected subscribers, depending on the operator's congestion mitigation policy.

The Np reference point supports the following functions:

- Reporting of RUCI from the RCAF to the PCRF.
- Sending, updating and removal of the reporting restrictions from the PCRF to the RCAF as defined in clause 6.1.15.2.

3GPP TS 23.203 at 34.

### 6.1.15 Reporting of RAN user plane congestion information

#### 6.1.15.1 General

RAN User Plane Congestion Information (RUCI) is reported to the PCRF to enable the PCRF to take the RAN user plane congestion status into account for policy decisions.

The RUCI includes the following information:

- The IMSI identifying the UE impacted by congestion;
- eNB identifier, ECGI or SAI identifying the eNB, E-UTRAN cell or Service Area, respectively, serving the UE.

NOTE: Whether in case of E-UTRAN the eNB identifier or the ECGI is included in the RUCI is up to operator configuration in the RCAF.

- APN for which congestion information is reported;
- Congestion level or an indication of the "no congestion" state.

3GPP TS 23.203 at 62.

The 3GPP Standards further describe that the PCRF in the Accused Wireless Network may interface with other components, including the Bearer Binding and Event Reporting Function (BBERF), to implement policy decisions for UEs accessing non-3GPP mobile networks.

## Annex H (normative): Access specific aspects (EPC-based Non-3GPP)

### H.1 General

An EPC-based non-3GPP IP-CAN (TS 23.402 [18]), which requires the Gxa for dynamic QoS control, shall include the BBERF. The allocation of a BBERF to a node within the non-3GPP IP-CAN is out of 3GPP scope, unless otherwise specified in this Annex.

### H.2 EPC-based cdma2000 HRPD Access

In case of EPC-based cdma2000 HRPD access the BBERF is located in the HRPD Serving Gateway (HSGW) defined in 3GPP2 X.S0057 [20].

The HSGW of an EPC-based cdma2000 HRPD access that supports a Gxa interface shall support all the Gxa procedures defined in this specification.

3GPP TS 23.203 at 200.

### 4.1 General requirements

It shall be possible for the PCC architecture to base decisions upon subscription information.

It shall be possible to apply policy and charging control to any kind of 3GPP IP-CAN and any non-3GPP accesses connected via EPC complying with TS 23.402 [18]. Applicability of PCC to other IP-CANs is not restricted. However, it shall be possible for the PCC architecture to base decisions upon the type of IP-CAN used (e.g. GPRS, etc.).

3GPP TS 23.203 at 20.

On information and belief, AT&T's network architecture is similar to such PCC architectures and includes components like a PCRF that interfaces with other network elements to enforce policy and

charging rules, such as the Traffic Detection Function (TDF), Policy and Charging Enforcement Function (PCEF), Packet Data Network Gateway (P-GW), Serving Gateway (S-GW), and LTE Radio Access Network (E-UTRAN).

In addition, AT&T's network architecture includes analogous systems described in the 3GPP Standards for 5G mobile networks to implement a method for dynamic allocation of network resources. The policy and charging control framework of the 5G system relates to the dynamic allocation of network resources.

## 1 Scope

The present document defines the Stage 2 policy and charging control framework for the 5G System specified in TS 23.501 [2] and TS 23.502 [3].

The policy and charging control framework encompasses the following high level functions:

- Flow Based Charging for network usage, including charging control and online credit control, for service data flows;
- Policy control for session management and service data flows (e.g. gating control, QoS control, etc.);
- Management for access and mobility related policies;
- Management for UE access selection and PDU Session selection related policies.

3GPP TS 23.503 at 7. In particular, the policies impact the PDU Sessions within the network.

The 5G System policy and charging control framework is described with both a service-based representation and a reference point representation:

## 5.1 General

This specification describes the policy and charging control framework for the 5G system. The interaction between network functions is represented in two ways.

- A service-based representation, where network functions enable other authorized network functions to access their services. This representation also includes point-to-point reference points where necessary.
- A reference point representation, which shows that interactions exist between those network functions for which a reference point is depicted between them.

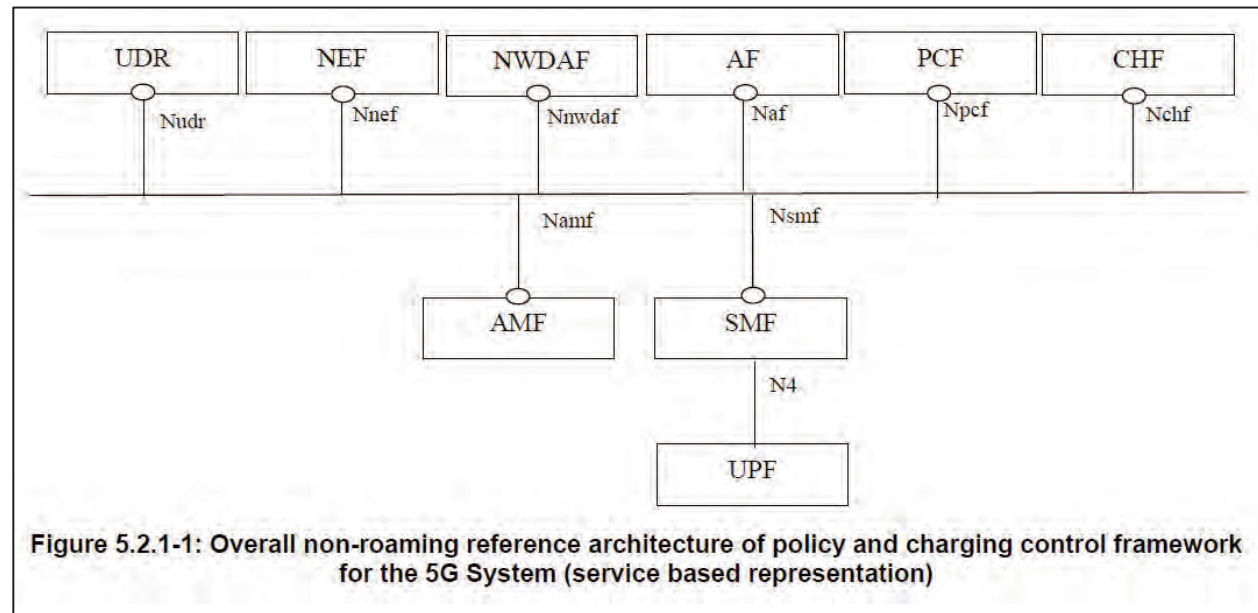
3GPP TS 23.503 at 17.

The reference architecture is comprised of the functions of many components:

The reference architecture of policy and charging control framework for the 5G System is comprised by the functions of the Policy Control Function (PCF), the Session Management Function (SMF), the User Plane Function (UPF), the Access and Mobility Management Function (AMF), the Network Exposure Functionality (NEF), the Network Data Analytics Function (NWDAF), the Charging Function (CHF), the Application Function (AF) and UDR (Unified Data Repository).

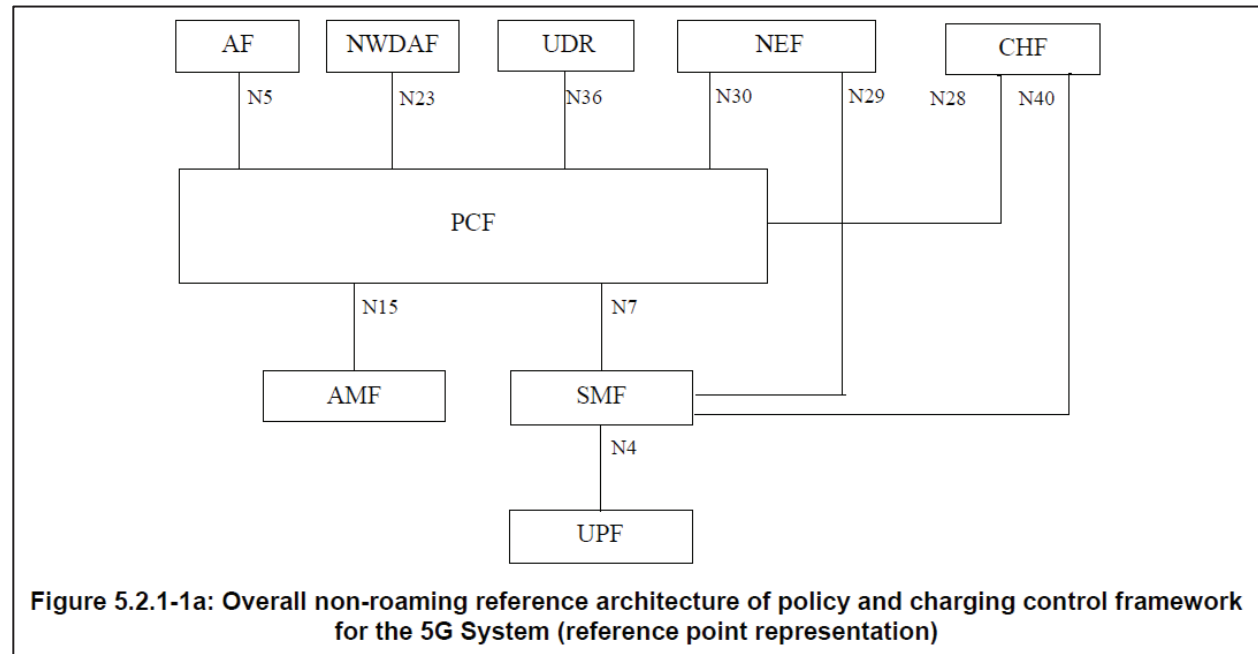
3GPP TS 23.503 at 17.

The following diagram illustrates the 5G policy and charging control framework as a service-based representation:



3GPP TS 23.503 at 18.

The following diagram illustrates the 5G policy and charging control framework as a reference point representation:



3GPP TS 23.503 at 18; *see also id.* at 18-20 (providing other PCC framework architecture diagrams). The PCF receives and uses information from various sources to make its policy-based decisions. Several examples are provided below.

## 6.2.1 Policy Control Function (PCF)

### 6.2.1.1 General

#### 6.2.1.1.1 Session management related functionality

The PCF provides the following session management related functionality:

- Policy and charging control for a service data flows;
- PDU Session related policy control;
- PDU Session event reporting to the AF.

The PCF provides authorized QoS for a service data flow and other network control regarding service data flow detection, gating, QoS and charging (except credit management) towards the SMF.

The PCF uses the service information received from the AF (e.g. SDP information or other available application information) and/or the subscription information received from the UDR to calculate the proper QoS authorization (QoS class identifier, bitrates). The PCF may also take into account the requested QoS received from the SMF and the analytics information (e.g. analytics related to "Service Experience") received from the NWDAF.

3GPP TS 23.503 at 60.

## 4.2.3 Network analytics information requirements

The PCF shall be able to collect directly network analytic information from the NWDAF. The NWDAF provides network data analytics (e.g. load level information on a network slice level) to PCF. The PCF shall be able to use those data in its policy decisions. The details are defined in clause 6.1.1.3.

3GPP TS 23.503 at 12.

#### 4.3.4 Usage monitoring control requirements

The requirements to monitor, both volume and time usage, and report the accumulated usage of network resources apply for PDU Sessions of type IP and Ethernet.

It shall be possible to apply usage monitoring for the accumulated usage of network resources on a per Session and user basis. This capability is required for enforcing dynamic policy decisions based on the total network usage in real-time.

The PCF that uses usage monitoring for making dynamic policy decisions shall set and send the applicable thresholds to the SMF for monitoring. The usage monitoring thresholds shall be based either on time, or on volume. The PCF may send both thresholds to the SMF. The SMF shall notify the PCF when a threshold is reached and report the accumulated usage since the last report for usage monitoring. If both time and volume thresholds were provided to the SMF, the accumulated usage since last report shall be reported when either the time or the volume thresholds are reached.

3GPP TS 23.503 at 16

#### 5.3.2 Interactions between PCF and SMF

Npcf and Nsmf enable the PCF to have dynamic control over the policy and charging behaviour at a SMF.

Npcf and Nsmf enable the signalling of policy and charging control decisions and support the following functionality:

- Creation of a SM Policy Association as defined in clause 4.16 of TS 23.502 [3];
- Request for policy and charging control decision from the SMF to the PCF when a Policy Control Request Trigger related to Session Management has been met;
- Provision of policy and charging control decision from the PCF to the SMF;
- Deletion of a SM Policy Association as defined in clause 4.16 of TS 23.502 [3].

The N7 reference point is defined for the interactions between PCF and SMF in the reference point representation.

3GPP TS 23.503 at 21.

### 5.3.11 Interactions between NWDAF and PCF

The Nnwdaf enables the PCF to subscribe to and be notified on slice load level analytics. The following information are notified by the NWDAF:

- Identifier of network slice instance;
- Load level information of network slice instance.

NOTE: How this information is used by the PCF is not standardized in this release of the specification.

The Nnwdaf enables the PCF to request or subscribe to and be notified on observed service experience (i.e. the average observed Service MoS) as described in clause 6.4 of TS 23.288 [24].

The Nnwdaf enables the PCF to request or subscribe to and be notified on network performance as described in clause 6.6 of TS 23.288 [24].

The Nnwdaf enables the PCF to request or subscribe to and be notified on UE related analytics as described in clause 6.7 of TS 23.288 [24].

The N23 reference point is defined for the interactions between NWDAF and PCF in the reference point representation.

3GPP TS 23.503 at 23-24.

### 6.1.1.3 Policy decisions based on network analytics

Policy decisions based on network analytics allow PCF to perform policy decisions taking into account the analytics information provided by the NWDAF. The PCF subscribes/unsubscribes to Analytics information as defined in TS 23.288 [24].

The following Analytics IDs are relevant for Policy decisions: "Load level information", "Service Experience", "Network Performance" and "Abnormal behaviour". The PCF may subscribe to notifications of network analytics related to "Load Level Information" using the Nnwdaf\_AnalyticsSubscription\_Subscribe service operation including the Analytics ID "Load level information", the Analytics Filter "S-NSSAI and NSI ID" and the Analytics Reporting Information set to a load level threshold value. The PCF is notified when the load level of the Network Slice Instance reaches the threshold, and then the PCF may verify if the RFSP index value needs to be modified for a SUPI for which an AM Policy Association is created; this is based on operator policies in the PCF, as defined in clause 6.1.2.1.

3GPP TS 23.503 at 26.

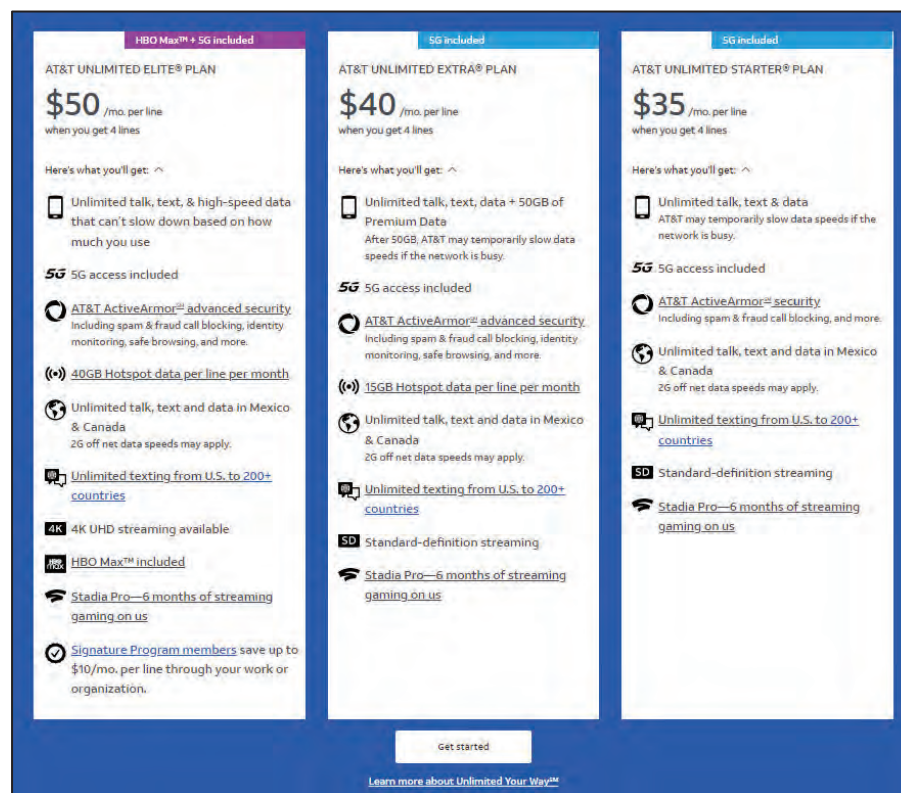
	<p><b>6.2.1.7 Usage monitoring</b></p> <p>The PCF supports usage monitoring control for a PDU Session or per Monitoring Key. Usage is defined as either volume or time of user plane traffic.</p> <p>The PCF may receive usage monitoring related information per DNN and S-NSSAI combination and UE from the UDR, i.e. the overall amount of allowed resources (based either on traffic volume and/or traffic time) that are to be monitored for the PDU Sessions of a user, together with the corresponding remaining allowed usage related information. In addition, usage monitoring related information for Monitoring key(s) per DNN and S-NSSAI combination and UE may also be received from the UDR, together with the corresponding remaining allowed usage related information. For the purpose of usage monitoring per access type, the PCF receives an individual Monitoring key per access type from UDR. Details about the usage monitoring related information and the remaining allowed usage related information provided by the UDR are described in clause 6.2.1.3.</p> <p>For the purpose of usage monitoring control the PCF shall request the Usage report trigger and provide the necessary usage threshold(s), either volume threshold, time threshold, or both volume threshold and time threshold, upon which the SMF shall report to the PCF. The PCF shall decide if and when to activate usage monitoring to the SMF.</p> <p>The PCF may provide a Monitoring time to the SMF for the Monitoring keys(s) and optionally specify a subsequent threshold value for the usage after the Monitoring time.</p> <p>3GPP TS 23.503 at 62.</p>
<p><b>1[B]</b> receiving a service profile for each of a plurality of devices sharing a network resource;</p>	<p>AT&amp;T's implementation of dynamic allocation of network resources includes performing the step of receiving a service profile for each of a plurality of devices sharing a network resource.</p> <p>AT&amp;T's Broadband Internet Access Services receives a service profile for each of a plurality of devices sharing a network resource. The service profile defines the level of data/service which a device will receive from a base station and/or cell tower or other carrier network resource during a particular access period. The service profile may include a data volume cap and/or bit-rate cap for AT&amp;T subscribers, depending upon the particular service plan they purchase from AT&amp;T, and network congestion. The service profile that is generated within the AT&amp;T network identifies the allotted levels of service for each customer so that the AT&amp;T network management system can allocate the shared network resources, especially during periods of congestion or heavy usage.</p> <p>Implementing AT&amp;T's Broadband Internet Access Services requires receiving a service profile (<i>e.g.</i>, a directive to regulate data speed, volume, or traffic) for each of a plurality of devices (<i>e.g.</i>, more than</p>

one “PCs, Smartphones, Tablets, Smart TVs, etc.)” sharing a network resource in order to prioritize customer data usage:

- “Congestion-based Data Management. One network management practice we use to manage our wireless network resources *may affect customers with most AT&T post-paid and AT&T PREPAID<sup>SM</sup> unlimited mobile data plans* (“AT&T Unlimited Data Plans”). During periods of congestion, these customers may experience reduced data speeds and increased latency as *compared to other customers using the same cell site* (“Congestion-based Data Management”). *Depending on the customer’s AT&T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan* (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans.” (<https://about.att.com/sites/broadband/network>)
- “*Customers subject to Congestion-based Data Management* will experience reduced speeds and increased latency only when they use data at a *cell site experiencing network congestion at the same moment*. As soon as the congestion at the cell site abates, or if the customer’s session migrates to an uncongested cell site, speeds and latency are not affected.” (<https://about.att.com/sites/broadband/network>)
- “*For customers on plans subject to a data usage threshold for triggering the foregoing congestion management practice*, we will notify them during each billing cycle when their usage reaches 75% of their threshold (so, for example, 16.5GB for plans with a 22GB threshold and 37.5GB for plans with a 50GB threshold) so they can adjust their usage to avoid network management practices that may result in slower data speeds.” (<https://about.att.com/sites/broadband/network>)

AT&T advertises that under certain wireless plans, “AT&T may temporarily slow data speeds if the network is busy.” The service profile for a particular user will impact whether their broadband access speed is reduced (sometimes after a certain data threshold is reached). On information and belief, AT&T

has offered and used similar plans in the past. Customers with these Data Plans may have an associated service profile (which is necessarily received by the AT&T network to be processed) that defines their data volume allotment and/or available data bit-rates for a given time period when accessing the AT&T network:



<https://www.att.com/plans/wireless/>

AT&T states that it may impose “maximum speed limit[s]” under certain wireless plans. Monthly volume data caps conveyed as part of the service profile form part of a customer’s service profile and are used to make prioritization determinations during periods of network congestion.

- “*Mobile Service.* Some AT&T mass market mobile broadband internet access services limit access to certain network technologies or *impose a maximum speed limit, which is outlined in the applicable data service plan*, subject to the factors and the network management practices that can affect network performance, discussed above. Other plans provide access to all available network technologies and provide customers with the highest speed available from the network at a particular location and at a given point of time based on the capabilities of the customer's device, subject to the factors and network management practices discussed above. In addition, some service plans include maximum data transmission rates for video and/or other data traffic. For example, the now grandfathered AT&T Unlimited Choice plan originally limited data transmission rates to 1.5 Mbps for video and 3.0 Mbps for other data traffic. *Similarly, some AT&T plans provide customers a monthly per line allotment of mobile hotspot/tethering usage after which the data transmission rate for tethered data for that device will be limited to a significantly slower speed (e.g., 128 Kbps) for the remainder of the bill cycle, as set forth in the terms of the plan.*”  
(<https://about.att.com/sites/broadband/performance>)
- “*Mobile Services. Service performance may be affected by* your proximity to a cell site, the capacity of the cell site, the technology at the cell site, the number of other users connected to the same cell site and the services they are using, the surrounding terrain, use inside a building or a moving vehicle, radio frequency interference, *your mobile data plan*, the capabilities of your device, applicable network management practices as discussed on this page, and the applications you use. In addition, AT&T has designed its wireless services to provide our customers with a high-quality voice experience during simultaneous voice and data sessions, which may affect data performance, including but not limited to a temporary reduction in speed to minimize the likelihood of dropped calls.”  
(<https://about.att.com/sites/broadband/performance>)

The 3GPP Standards describe the use of the PCRF and other network elements to transmit and receive information that affect the provision of services to AT&T UEs. For instance, the dynamic PCC Rule, PCC decision, PCC rule, QoS rule, and service data flow template all relate to information that is transmitted and received within an operator network to implement policy charging and control.

**PCC decision:** A decision consists of PCC rules and IP-CAN bearer attributes and is provided by the PCRF to the PCEF for policy and charging control and, for PCEF enhanced with ADC, application detection and control.

**PCC rule:** A set of information enabling the detection of a service data flow and providing parameters for policy control and/or charging control and, for PCEF enhanced with ADC, for application detection and control.

**policy control:** The process whereby the PCRF indicates to the PCEF how to control the IP-CAN bearer. Policy control includes QoS control and/or gating control.

**QoS rule:** A set of information enabling the detection of a service data flow and defining its associated QoS parameters.

**service data flow template:** The set of service data flow filters in a PCC Rule or an application identifier in a PCC rule referring to an application detection filter, required for defining a service data flow.

3GPP TS 23.203 at 17-18.

PCRF decisions are based in part on service profile information. “The PCRF provides network control regarding the service data flow detection, gating, QoS and flow based charging (except credit management) towards the PCEF and/or TDF. . . . The PCRF shall decide whether application traffic detection is applicable, as per operator policies, based on user profile configuration, received within subscription information. The PCRF shall decide how certain service/application traffic shall be treated in the PCEF and in the TDF, if applicable, and ensure that the PCEF user plane traffic mapping and treatment is in accordance with the user's subscription profile.” 3GPP TS 23.203 at 71. “The PCRF may check that the service information provided by the AF is consistent with both the operator defined policy rules and the related subscription information as received from the SPR during IP-CAN session establishment before storing the service information.” *Id.* at 72. “The PCRF authorizes QoS resources. The PCRF uses the service information received from the AF (e.g. SDP information or other available application information) and/or the subscription information received from the SPR to calculate the proper QoS authorization (QoS class identifier, bitrates).” *Id.* “The PCRF may use the subscription information as basis for the policy and charging control decisions.” *Id.*

### 6.2.1.2 Subscription information management in the PCRF

The PCRF may request subscription information from the SPR for an IP-CAN session at establishment or a gateway control session at establishment. The subscription information may include user profile configuration indicating whether application detection and control should be enabled. The PCRF should specify the subscriber ID and, if available, the PDN identifier in the request. The PCRF should retain the subscription information that is relevant for PCC decisions until the IP-CAN session termination and the gateway control session termination.

The PCRF may request notifications from the SPR on changes in the subscription information. Upon reception of a notification, the PCRF shall make the PCC decisions necessary to accommodate the change in the subscription and updates the PCEF and/or the BBERF and/or the TDF by providing the new PCC and/or QoS and/or ADC decisions if needed. The PCRF shall send a cancellation notification request to the SPR when the related subscription information has been deleted.

3GPP TS 23.203 at 79.

The PCEF also participates in the policy enforcement decisions based on information from the PCRF and other network elements.

## 6.2.2 Policy and Charging Enforcement Function (PCEF)

### 6.2.2.1 General

The PCEF encompasses service data flow detection, policy enforcement and flow based charging functionalities.

This functional entity is located at the Gateway (e.g. GGSN in the GPRS case, and PDG in the WLAN case). It provides service data flow detection, user plane traffic handling, triggering control plane session management (where the IP-CAN permits), QoS handling, and service data flow measurement as well as online and offline charging interactions.

A PCEF shall ensure that an IP packet, which is discarded at the PCEF as a result from PCC rule enforcement or flow based charging, is neither reported for offline charging nor cause credit consumption for online charging.

3GPP TS 23.203 at 83.

The PCEF is enforcing the Policy Control as indicated by the PCRF in two different ways:

- Gate enforcement. The PCEF shall allow a service data flow, which is subject to policy control, to pass through the PCEF if and only if the corresponding gate is open;
- QoS enforcement:
  - QoS class identifier correspondence with IP-CAN specific QoS attributes. The PCEF shall be able to convert a QoS class identifier value to IP-CAN specific QoS attribute values and determine the QoS class identifier value from a set of IP-CAN specific QoS attribute values.
  - PCC rule QoS enforcement. The PCEF shall enforce the authorized QoS of a service data flow according to the active PCC rule (e.g. to enforce uplink DSCP marking).
  - IP-CAN bearer QoS enforcement. The PCEF controls the QoS that is provided to a combined set of service data flows. The policy enforcement function ensures that the resources which can be used by an authorized set of service data flows are within the "authorized resources" specified via the Gx interface by "authorized QoS". The authorized QoS provides an upper bound on the resources that can be reserved (GBR) or allocated (MBR) for the IP-CAN bearer. The authorized QoS information is mapped by the PCEF to IP-CAN specific QoS attributes. During IP-CAN bearer QoS enforcement, if packet filters are provided to the UE, the PCEF shall provide packet filters with the same content as that in the SDF template filters received over the Gx interface.

3GPP TS 23.203 at 84.

The PCEF is enforcing the charging control in the following way:

- For a service data flow (defined by an active PCC rule) that is subject to charging control, the PCEF shall allow the service data flow to pass through the PCEF if and only if there is a corresponding active PCC rule with and, for online charging, the OCS has authorized credit for the charging key. The PCEF may let a service data flow pass through the PCEF during the course of the credit re-authorization procedure.

For a service data flow (defined by an active PCC rule) that is subject to both Policy Control and Charging Control, the PCEF shall allow the service data flow to pass through the PCEF if and only if the right conditions from both policy control and charging control happen. I.e. the corresponding gate is open and in case of online charging the OCS has authorized credit for its charging key.

For a service data flow (defined by an active PCC rule) that is subject to policy control only and not charging control, the PCEF shall allow the service data flow to pass through the PCEF if and only if the conditions for policy control are met.

A PCEF may be served by one or more PCRF nodes. The PCEF shall contact the appropriate PCRF based on the packet data network (PDN) connected to, together with, a UE identity information (if available, and which may be IP-CAN specific). It shall be possible to ensure that the same PCRF is contacted for a specific UE irrespective of the IP-CAN used.

3GPP TS 23.203 at 84.

Each session may be associated with a PCC rule that includes specified QoS parameters derived from service profile information.

For the authorization of a PCC rule the PCRF shall take into account the IP-CAN specific restrictions and other information available to the PCRF. Each PCC rule receives a set of QoS parameters that can be supported by the IP-CAN. The authorization of a PCC rule associated with an emergency service and Restricted Local Operator Services shall be supported without subscription information (e.g. information stored in the SPR). The PCRF shall apply policies configured for the emergency service and Restricted Local Operator Services.

When both a Gx and associated Gxx interface(s) exist for an IP-CAN session, the PCRF shall generate QoS rules for all the authorized PCC rules in this step. The PCRF shall ensure consistency between the QoS rules and PCC rules authorized for the same service data flow when QoS rules are derived from corresponding PCC rules.

When flow mobility applies for the IP-CAN Session, one IP-CAN session may be associated to multiple Gateway Control Sessions with separate BBRFs. In this case, the PCRF shall provision QoS rules only to the appropriate BBERF based on IP flow mobility routing rules received from the PCEF.

3GPP TS 23.203 at 38.

The 3GPP Standards describe that a PCRF can maintain UE-specific policy information that corresponds to each of a plurality of devices sharing a network resource. For example, the PCRF can act based on inputs that have UE identity information, such as IMSIs, for IP-CAN sessions between a UE and an operator's IP services network.

**IP-CAN session:** The association between a UE and an IP network. The association is identified by one IPv4 and/or an IPv6 prefix together with UE identity information, if available, and a PDN represented by a PDN ID (e.g. an APN). An IP-CAN session incorporates one or more IP-CAN bearers. Support for multiple IP-CAN bearers per IP-CAN session is IP-CAN specific. An IP-CAN session exists as long as UE IP addresses/prefix are established and announced to the IP network.

3GPP TS 23.203 at 17.

#### 6.4 IP-CAN bearer and IP-CAN session related policy information

The purpose of the IP-CAN bearer and IP-CAN session related policy information is to provide policy and charging control related information that is applicable to a single IP-CAN bearer or the whole IP-CAN session respectively. The PCRF provides the IP-CAN bearer and IP-CAN session related policy information to the PCEF and BBERF (if applicable) using the PCC rule and QoS rule (if applicable) provision procedure. The IP-CAN bearer related policy information may be provided together with rules or separately.

Table 6.4 lists the PCC related IP-CAN bearer and IP-CAN session related policy information.

3GPP TS 23.203 at 108; *see also id.* at 109 (listing attributes in Table 6.4).

#### 6.4b APN related policy information

The purpose of the APN related policy information is to provide policy and charging control related information that is applicable to all IP-CAN sessions of a UE to the same APN. The PCRF provides APN related policy information to the PCEF using the PCC provision procedure together with PCC rules or separately.

Table 6.4b-1 lists the applicable PCC specific APN related policy information.

3GPP TS 23.203 at 111; *see also id.* at 112 (listing attributes in Table 6.4b-1).

Service profile information is also used to implement QoS controls within the operator network.

#### 4.3.3 QoS control

##### 4.3.3.1 QoS control at service data flow level

It shall be possible to apply QoS control on a per service data flow basis in the PCEF.

QoS control per service data flow allows the PCC architecture to provide the PCEF with the authorized QoS to be enforced for each specific service data flow. Criteria such as the QoS subscription information may be used together with policy rules such as, service-based, subscription-based, or predefined PCRF internal policies to derive the authorized QoS to be enforced for a service data flow.

It shall be possible to apply multiple PCC rules, without application provided information, using different authorised QoS within a single IP-CAN session and within the limits of the Subscribed QoS profile.

3GPP TS 23.203 at 24.

#### 4.3.3.2 QoS control at IP-CAN bearer level

It shall be possible for the PCC architecture to support control of QoS reservation procedures (UE-initiated or network-initiated) for IP-CANs that support such procedures for its IP-CAN bearers in the PCEF or the BBERF, if applicable. It shall be possible to determine the QoS to be applied in QoS reservation procedures (QoS control) based on the authorised QoS of the service data flows that are applicable to the IP-CAN bearer and on criteria such as the QoS subscription information, service based policies, and/or predefined PCRF internal policies. Details of QoS reservation procedures are IP-CAN specific and therefore, the control of these procedures is described in Annex A and Annex D.

It shall be possible for the PCC architecture to support control of QoS for the packet traffic of IP-CANs.

The PCC architecture shall be able to provide policy control in the presence of NAT devices. This may be accomplished by providing appropriate address and port information to the PCRF.

The enforcement of the control for QoS reservation procedures for an IP-CAN bearer shall allow for a downgrading or an upgrading of the requested QoS as part of a UE-initiated IP-CAN bearer establishment and modification. The PCC architecture shall be able to provide a mechanism to initiate IP-CAN bearer establishment and modification (for IP-CANs that support such procedures for its bearers) as part of the QoS control.

The IP-CAN shall prevent cyclic QoS upgrade attempts due to failed QoS upgrades.

NOTE: These measures are IP-CAN specific.

The PCC architecture shall be able to handle IP-CAN bearers that require a guaranteed bitrate (GBR bearers) and IP-CAN bearers for which there is no guaranteed bitrate (non-GBR bearers).

3GPP TS 23.203 at 24.

The 3GPP Standards also describe the use of a PCRF to maintain service profile information based on UE-specific subscriber information received from a Subscriber Profile Repository (SPR) or User Data Repository (UDR). *See* 3GPP TS 23.203 at 28-29 (illustrating different architecture diagrams using SPR and/or UDR).

### 5.2.3 Reference points to subscriber databases

#### 5.2.3.1 Sp reference point

The Sp reference point lies between the SPR and the PCRF.

The Sp reference point allows the PCRF to request subscription information related to the IP-CAN transport level policies from the SPR based on a subscriber ID, a PDN identifier and possible further IP-CAN session attributes, see Annex A and Annex D. For example, the subscriber ID can be IMSI. The reference point allows the SPR to notify the PCRF when the subscription information has been changed if the PCRF has requested such notifications. The SPR shall stop sending the updated subscription information when a cancellation notification request has been received from the PCRF.

NOTE: The details associated with the Sp reference point are not specified in this Release.

#### 5.2.3.2 Ud reference point

The Ud reference point resides between the UDR and the PCRF, acting as an Application Frontend as defined in TS 23.335 [25]. It is used by the PCRF to access PCC related subscription data when stored in the UDR.

The details for this reference point are described in TS 23.335 [25] and TS 29.335 [26].

3GPP TS 23.203 at 32.

The SPR is described in Section 6.2.4 of 3GPP TS 23.203.

### 6.2.4 Subscription Profile Repository (SPR)

The SPR logical entity contains all subscriber/subscription related information needed for subscription-based policies and IP-CAN bearer level PCC rules by the PCRF. The SPR may be combined with or distributed across other databases in the operator's network, but those functional elements and their requirements for the SPR are out of scope of this document.

3GPP TS 23.203 at 94.

The SPR may provide the following subscription profile information (per PDN, which is identified by the PDN identifier):

- Subscriber's allowed services;
- For each allowed service, a pre-emption priority;
- Information on subscriber's allowed QoS, including the Subscribed Guaranteed Bandwidth QoS;
- Subscriber's charging related information (e.g. location information relevant for charging);
- Subscriber's User CSG Information reporting rules;
- List of Presence Reporting Area identifiers and optionally the elements for one or more of the Presence Reporting Areas;
- Subscriber category;
- Subscriber's usage monitoring related information;
- MPS EPS Priority and MPS Priority Level;
- IMS Signalling Priority;
- Subscriber's profile configuration indicating whether application detection and control can be enabled;
- Spending limits profile containing an indication that policy decisions are based on policy counters available at OCS that has a spending limit associated with it and optionally the list of policy counters.

3GPP TS 23.203 at 94; *see generally id.* at Section 6.2.4.

The User Data Repository also maintain subscriber-based information similar to that of the SPR.

### 6.2.8 User Data Repository (UDR)

The UDR is a functional entity that acts as a single logical repository storing user data. As such it may contain all subscriber/subscription related information needed by the PCRF. In deployment scenarios where the UDR is used it replaces the SPR. The UDR provides a unique reference point to fetch these subscriber/subscription data. This reference point is named Ud. More information on the UDR can be found in TS 23.335 [25].

3GPP TS 23.203 at 96.

	<p>In addition to the use of 4G PCC architecture referenced above, the AT&amp;T operator network adopts an analogous PCC framework from the 3GPP Standards for its 5G mobile network, thereby implementing a method for receiving a service profile for each of a plurality of devices sharing a network resource.</p> <p>Several network functions described in the 3GPP Standards transmit and receive information elements to enforce policy decisions for services provided to UEs that access AT&amp;T's 5G network, such as the Policy Control Function (PCF), Access and Mobility Management Function (AMF), Session Management Function (SMF), Application Function (AF), Charging Function (CHF), Unified Data Repository (UDR), Network Exposure Functionality (NEF), and Network Data Analytics Function (NWDAF). <i>See</i> 3GPP TS 23.503 at 17; <i>see also, e.g.</i>, 3GPP TS 23.503 at 9 (defining dynamic PCC rule, PCC decision, PCC rule, policy control, and service data flow template for 5G systems); <i>id.</i> at 17-20 (5G reference architecture); <i>id.</i> at 4748 (QoS parameters in service data flow template); <i>id.</i> at 60-62 (Policy Control Function); <i>id.</i> at 63-66 (input for PCC decisions including service profile information); <i>id.</i> at 66-69 (Policy control subscription information management); <i>id.</i> at 70-72 (Session Management Function); <i>id.</i> at 90-94 (PDU Session related policy information); <i>id.</i> at 96-97 (Access and mobility related policy information); <i>id.</i> at 97 (UE access selection and PDU Session selection related policy information); <i>id.</i> at 15 (QoS control requirements at service data flow level, QoS flow level, and PDU Session level).</p>
<p><b>1[C]</b> receiving a billing profile for each of said plurality of devices;</p>	<p>AT&amp;T's implementation of dynamic allocation of network resources includes performing the step of receiving a billing profile for each of said plurality of devices.</p> <p>AT&amp;T's Broadband Internet Access Services receives a billing profile for each of said plurality of devices. The billing profile includes a billing parameter that regulates rating or charging or both of traffic to and from the device. For example, the billing profile may include a rate or charge that each customer pays for accessing the AT&amp;T Services and/or an identification of current network usage for a given billing cycle, such as the amount of premium or high-speed data used or the amount of data used as a high-speed mobile hotspot for a given month. These examples are non-limiting, as other information regarding billing, billing history, usage and usage history may also form part of the billing profile.</p> <p>Implementing AT&amp;T's Broadband Internet Access Services requires receiving a billing profile for each of said plurality of devices (<i>e.g.</i>, a specific data plan), which factors into the prioritization scheme:</p>

- “Congestion-based Data Management. One network management practice we use to manage our wireless network resources *may affect customers with most AT&T post-paid and AT&T PREPAID<sup>SM</sup> unlimited mobile data plans (“AT&T Unlimited Data Plans”).* During periods of congestion, these customers may experience reduced data speeds and increased latency as *compared to other customers using the same cell site (“Congestion-based Data Management”). Depending on the customer’s AT&T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan* (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans.” (<https://about.att.com/sites/broadband/network>)
- “*Customers subject to Congestion-based Data Management* will experience reduced speeds and increased latency only when they use data at a *cell site experiencing network congestion at the same moment*. As soon as the congestion at the cell site abates, or if the customer’s session migrates to an uncongested cell site, speeds and latency are not affected.” (<https://about.att.com/sites/broadband/network>)
- “*For customers on plans subject to a data usage threshold for triggering the foregoing congestion management practice*, we will notify them during each billing cycle when their usage reaches 75% of their threshold (so, for example, 16.5GB for plans with a 22GB threshold and 37.5GB for plans with a 50GB threshold) so they can adjust their usage to avoid network management practices that may result in slower data speeds.” (<https://about.att.com/sites/broadband/network>)

AT&T advertises that under certain wireless plans, “AT&T may temporarily slow data speeds if the network is busy.” The service profile for a particular user will impact whether their broadband access speed is reduced (sometimes after a certain data threshold is reached):

The screenshot displays three AT&T wireless plans side-by-side. The first plan, 'AT&T UNLIMITED ELITE® PLAN', is priced at \$50/mo. per line and includes HBO Max™ and 5G access. The second plan, 'AT&T UNLIMITED EXTRA® PLAN', is priced at \$40/mo. per line and includes 5G access. The third plan, 'AT&T UNLIMITED STARTER® PLAN', is priced at \$35/mo. per line and includes 5G access. All plans offer unlimited talk, text, and data, with varying levels of hotspot data and international coverage. A 'Get started' button and a link to 'Learn more about Unlimited Your Way™' are at the bottom.

Plan Name	Price	Key Features
AT&T UNLIMITED ELITE® PLAN	\$50/mo. per line	HBO Max™ + 5G included, 40GB Hotspot data, 4K UHD streaming, Signature Program members save up to \$10/mo.
AT&T UNLIMITED EXTRA® PLAN	\$40/mo. per line	5G access included, 15GB Hotspot data, Standard-definition streaming.
AT&T UNLIMITED STARTER® PLAN	\$35/mo. per line	5G access included, Standard-definition streaming, Stadia Pro—6 months of streaming gaming on us.

<https://www.att.com/plans/wireless/>

AT&T states that it may impose “maximum speed limit[s]” under certain wireless plans:

- “*Mobile Service.* Some AT&T mass market mobile broadband internet access services limit access to certain network technologies or ***impose a maximum speed limit, which is outlined in the applicable data service plan,*** subject to the factors and the network management practices that can affect network performance, discussed above. Other plans provide access to all available network technologies and provide customers with the highest speed available from the network at a particular location and at a given point of time based on the capabilities of the customer's device, subject to the factors and network management practices discussed above. In

	<p>addition, some service plans include maximum data transmission rates for video and/or other data traffic. For example, the now grandfathered AT&amp;T Unlimited Choice plan originally limited data transmission rates to 1.5 Mbps for video and 3.0 Mbps for other data traffic. <i>Similarly, some AT&amp;T plans provide customers a monthly per line allotment of mobile hotspot/tethering usage after which the data transmission rate for tethered data for that device will be limited to a significantly slower speed (e.g., 128 Kbps) for the remainder of the bill cycle, as set forth in the terms of the plan.</i>” (<a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</p> <ul style="list-style-type: none"> <li>• “Mobile Services. <i>Service performance may be affected by</i> your proximity to a cell site, the capacity of the cell site, the technology at the cell site, the number of other users connected to the same cell site and the services they are using, the surrounding terrain, use inside a building or a moving vehicle, radio frequency interference, <i>your mobile data plan</i>, the capabilities of your device, applicable network management practices as discussed on this page, and the applications you use. In addition, AT&amp;T has designed its wireless services to provide our customers with a high-quality voice experience during simultaneous voice and data sessions, which may affect data performance, including but not limited to a temporary reduction in speed to minimize the likelihood of dropped calls.” (<a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</li> </ul> <p>AT&amp;T explains to its customers that with respect to AT&amp;T’s “unlimited” plans, “unlimited does not mean that wireless data will be transmitted at any particular speed.”</p> <ul style="list-style-type: none"> <li>• “If you are subscribed to an AT&amp;T unlimited data plan, you agree that “unlimited” means you pay a single monthly flat rate for wireless Data Service regardless of how much data you use. <i>You further agree that “unlimited” does not mean that wireless data will be transmitted at any particular speed</i> or that you can use AT&amp;T’s wireless Data Service in any way that you choose or for any Prohibited Network Uses. If you use your unlimited data plan in any manner that is prohibited, AT&amp;T can limit, restrict, suspend or terminate your Data Service. We may also migrate you from the unlimited data plan to a tiered data plan and charge you the appropriate monthly fees. We will provide you with notice of this change at least one billing period in advance either by a bill message, email, text message, or other appropriate means. Except for FirstNet individual users, AT&amp;T may also reduce your data throughput speeds at any time based</li> </ul>
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on the terms of your data plan, which may include times when your usage exceeds an applicable, identified data usage threshold during any billing period. ***Reduced data throughput speeds mean you may experience reduced data speeds and increased latency, which may cause websites to load more slowly and affect the performance of data-heavy activities such as video streaming.*** Reduced data throughput speeds apply when using Data Services at times and in areas experiencing network congestion compared to other customers using the same cell site. Standard speeds will resume once the cell site is no longer congested or when your data session moves to an uncongested cell site, and speeds will no longer be reduced during periods of network congestion at the start of your next billing period, ***unless your usage again exceeds an applicable, identified data usage threshold for that next billing period.*** There are no mobile network-related speed reductions if you use Wi-Fi, and Wi-Fi data usage does not count against a monthly data usage threshold for wireless Data service. For more information, go to att.com/broadbandinfo and att.com/datainfo.”  
<https://www.att.com/legal/terms.consumerServiceAgreement.html>)

The 3GPP Standards describe the use of the PCRF in AT&T’s operator network and other network elements that transmit and receive UE-specific information pertaining to AT&T’s subscribers.

#### 4.2.2 Charging models

The PCC charging shall support the following charging models both for charging performed by PCEF and charging performed by TDF:

- Volume based charging;
- Time based charging;
- Volume and time based charging;
- Event based charging;
- No charging.

NOTE 1: The charging model - "No charging" implies that charging control is not applicable.

3GPP TS 23.203 at 21.

The billing profile governs, in part, the manner in which charging models are built and implemented within the operator network.

#### 4.2.2a Charging requirements

The requirements in this clause apply to both PCC rules based charging and ADC rules based charging unless exceptions are explicitly mentioned.

It shall be possible to apply different rates and charging models when a user is identified to be roaming from when the user is in the home network. Furthermore, it shall be possible to apply different rates and charging models based on the location of a user, beyond the granularity of roaming.

It shall be possible to apply different rates and charging models when a user consuming network services via a CSG cell or a hybrid cell according to the user CSG information. User CSG information includes CSG ID, access mode and CSG membership indication.

It shall be possible to apply a separate rate to a specific service, e.g. allow the user to download a certain volume of data, reserved for the purpose of one service for free, and then continue with a rate causing a charge.

It shall be possible to change the rate based on the time of day.

It shall be possible to enforce per-service identified by PCC Rule/per-application identified by ADC Rule usage limits for a service data flow using online charging on a per user basis (may apply to prepaid and post-paid users).

It shall be possible to apply different rates depending on the access used to carry a Service Data Flow. This applies also to a PDN connection supporting NBIFOM.

It shall be possible for the online charging system to set and send the thresholds (time and/or volume based) for the amount of remaining credit to the PCEF or TDF for monitoring. In case the PCEF or TDF detects that any of the time based or volume based credit falls below the threshold, the PCEF or TDF shall send a request for credit re-authorization to the OCS with the remaining credit (time and/or volume based).

3GPP TS 23.203 at 22.

It shall be possible for the charging system to select the applicable rate based on:

- home/visited IP-CAN;
- User CSG information;
- IP-CAN bearer characteristics (e.g. QoS);
- QoS provided for the service;
- time of day;
- IP-CAN specific parameters according to Annex A.

3GPP TS 23.203 at 22.

The charging system maintains the tariff information, determining the rate based on the above input. Thus the rate may change e.g. as a result of IP-CAN session modification to change the bearer characteristics provided for a service data flow.

The charging rate or charging model applicable to a service data flow/detected application traffic may change as a result of events in the service (e.g. insertion of a paid advertisement within a user requested media stream).

The charging model applicable to a service data flow/detected application traffic may change as a result of events identified by the OCS (e.g. after having spent a certain amount of time and/or volume, the user gets to use some services for free).

The charging rate or charging model applicable to a service data flow/detected application traffic may change as a result of having used the service data flow/detected application traffic for a certain amount of time and/or volume.

For online charging, it shall be possible to apply an online charging action upon PCEF or TDF events (e.g. re-authorization upon QoS change).

3GPP TS 23.203 at 22.

The Subscription Profile Repository also contains billing profile related information.

#### 6.2.4 Subscription Profile Repository (SPR)

The SPR logical entity contains all subscriber/subscription related information needed for subscription-based policies and IP-CAN bearer level PCC rules by the PCRF. The SPR may be combined with or distributed across other databases in the operator's network, but those functional elements and their requirements for the SPR are out of scope of this document.

NOTE 1: The SPR's relation to existing subscriber databases is not specified in this Release.

The SPR may provide the following subscription profile information (per PDN, which is identified by the PDN identifier):

- Subscriber's allowed services;
- For each allowed service, a pre-emption priority;
- Information on subscriber's allowed QoS, including the Subscribed Guaranteed Bandwidth QoS;
- Subscriber's charging related information (e.g. location information relevant for charging);
- Subscriber's User CSG Information reporting rules;
- List of Presence Reporting Area identifiers and optionally the elements for one or more of the Presence Reporting Areas;
- Subscriber category;
- Subscriber's usage monitoring related information;
- MPS EPS Priority and MPS Priority Level;
- IMS Signalling Priority;
- Subscriber's profile configuration indicating whether application detection and control can be enabled.
- Spending limits profile containing an indication that policy decisions are based on policy counters available at OCS that has a spending limit associated with it and optionally the list of policy counters.

3GPP TS 23.203 at 94; *see also* 1[B] (describing SPR and UDR).

In addition to the use of 4G PCC architecture referenced above, the AT&T operator network adopts an analogous PCC framework from the 3GPP Standards for its 5G mobile network, thereby implementing a method for receiving a billing profile for each of said plurality of devices.

	<p>Several network functions described in the 3GPP Standards transmit and receive information elements to enforce policy decisions for services provided to UEs that access AT&amp;T's 5G network. <i>See</i> 1[B] (detailing 5G equivalents for 3GPP network elements); <i>see also, e.g.</i>, 3GPP TS 23.503 at 14-15 (charging models and charging requirements); <i>id.</i> at 23 (PCF obtains information relating to subscriber spending from Charging Function); <i>id.</i> at 54 (PCF decisions based on policy counters maintained in Charging Function); <i>id.</i> at 61 (PCF uses information relating to subscriber spending in CHF as input for policy decisions related to QoS control, gating or charging conditions); <i>id.</i> at 63 (input for PCC decisions from CHF and UDR); <i>id.</i> at 66-69 (Policy control subscription information management).</p>
<p><b>1[D]</b> generating a prioritization list defining an order of said plurality of devices, based on said billing profiles and on a billing history for each of said plurality of devices;</p>	<p>AT&amp;T's Broadband Internet Access Services generate a prioritization list that is in part based on the billing profiles and a billing history (which identifies historical charges, usage, and payment). Prioritization will consider the specific plan features (which comprise part of the billing profile) and previous data usage (which comprises part of the billing history) for each of the devices at issue.</p> <p><i>See</i> 1[B] and 1[C] (detailing different situations in which prioritization amongst users, devices, and plans occurs).</p> <p>The prioritization list defines an order for the plurality of devices accessing a shared network resource (<i>e.g.</i>, a cell tower or base station or backhaul link), based on the billing profiles and billing history for each of the plurality of devices. For example, on information and belief, AT&amp;T generates a prioritization list to determine which, if any, device will see a decrease in data speed based on, in part, the plan associated with the device (which is part of the "billing profile") and the amount and/or type of data transmitted under that plan for a particular billing period or whether a user has failed to pay amounts owed AT&amp;T (which forms part of the billing history). On information and belief, whether a user's device will experience decreased data speeds depends on, in part, the billing profile (<i>e.g.</i>, specific plan) and the billing history (<i>e.g.</i>, data usage for a particular billing period).</p> <p>Implementing AT&amp;T's Broadband Internet Access Services requires generating a prioritization list that is in part based on the billing profiles and a billing history (<i>e.g.</i>, prioritization will consider the specific plan, features, and/or previously paid data usage) for each of the devices.</p> <p>AT&amp;T prioritizes certain user's traffic over others:</p> <ul style="list-style-type: none"> <li>• "Congestion-based Data Management. One network management practice we use to manage our wireless network resources <i>may affect customers with most AT&amp;T post-paid and AT&amp;T PREPAID<sup>SM</sup> unlimited mobile data plans</i> ("AT&amp;T Unlimited Data Plans"). During periods</li> </ul>

of congestion, these customers may experience reduced data speeds and increased latency as compared to other customers using the same cell site (“Congestion-based Data Management”). ***Depending on the customer’s AT&T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan*** (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans.” (<https://about.att.com/sites/broadband/network>)

This prioritization is based on the billing profile (e.g., data plan) and billing history (e.g., high speed usage during your billing cycle) associated with the device:

- “***For customers on plans subject to a data usage threshold for triggering the foregoing congestion management practice***, we will notify them during each billing cycle when their usage reaches 75% of their threshold (so, for example, 16.5GB for plans with a 22GB threshold and 37.5GB for plans with a 50GB threshold) so they can adjust their usage to avoid network management practices that may result in slower data speeds.” (<https://about.att.com/sites/broadband/network>)
- “Congestion-based Data Management. One network management practice we use to manage our wireless network resources ***may affect customers with most AT&T post-paid and AT&T PREPAID<sup>SM</sup> unlimited mobile data plans*** (“AT&T Unlimited Data Plans”). During periods of congestion, these customers may experience reduced data speeds and increased latency as compared to other customers using the same cell site (“Congestion-based Data Management”). ***Depending on the customer’s AT&T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan*** (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a

single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans.”  
<https://about.att.com/sites/broadband/network>)

The screenshot displays three AT&T Unlimited Data Plans side-by-side. Each plan includes a price per line, a list of features, and a 'Get started' button at the bottom.

Plan Name	Price /mo. per line (when you get 4 lines)	Key Features
AT&T UNLIMITED ELITE® PLAN	\$50	<ul style="list-style-type: none"> <li>Unlimited talk, text, &amp; high-speed data that can't slow down based on how much you use</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® advanced security (including spam &amp; fraud call blocking, identity monitoring, safe browsing, and more)</li> <li>40GB Hotspot data per line per month</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>4K UHD streaming available</li> <li>HBO Max™ included</li> <li>Stadia Pro—6 months of streaming gaming on us</li> <li>Signature Program members save up to \$10/mo. per line through your work or organization</li> </ul>
AT&T UNLIMITED EXTRA® PLAN	\$40	<ul style="list-style-type: none"> <li>Unlimited talk, text, data + 50GB of Premium Data (After 50GB, AT&amp;T may temporarily slow data speeds if the network is busy)</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® advanced security (including spam &amp; fraud call blocking, identity monitoring, safe browsing, and more)</li> <li>15GB Hotspot data per line per month</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>Standard-definition streaming</li> <li>Stadia Pro—6 months of streaming gaming on us</li> </ul>
AT&T UNLIMITED STARTER® PLAN	\$35	<ul style="list-style-type: none"> <li>Unlimited talk, text &amp; data (AT&amp;T may temporarily slow data speeds if the network is busy)</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® security (including spam &amp; fraud call blocking, and more)</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>Standard-definition streaming</li> <li>Stadia Pro—6 months of streaming gaming on us</li> </ul>

At the bottom of the page, there is a 'Get started' button and a link: [Learn more about Unlimited Your Way™](#).

<https://www.att.com/plans/wireless/>

The 3GPP Standards describe the use of 4G PCC architecture to prioritize services to certain UEs based on billing profiles and billing history information. For example, the PCRF can receive information from various sources as inputs to build PCC rules that affect the provision of services to UEs.

### 6.1.6 Service (data flow) Prioritization and Conflict Handling

Service pre-emption priority enables the PCRF to resolve conflicts where the activation of all requested active PCC rules for services would result in a cumulative authorized QoS which exceeds the Subscribed Guaranteed bandwidth QoS.

For example, when supporting network controlled QoS, the PCRF may use the pre-emption priority of a service, the activation of which would cause the subscriber's authorized QoS to be exceeded. If this pre-emption priority is greater than that of any one or more active PCC rules, the PCRF can determine whether the deactivation of any one or more such rules would allow the higher pre-emption priority PCC rule to be activated whilst ensuring the resulting cumulative QoS does not exceed a subscriber's Subscribed Guaranteed Bandwidth QoS.

If such a determination can be made, the PCRF may resolve the conflict by deactivating those selected PCC rules with lower pre-emption priorities and accepting the higher priority service information from the AF. If such a determination cannot be made, the PCRF may reject the service information from the AF.

3GPP TS 23.203 at 48.

#### 6.2.1.1 Input for PCC decisions

The PCRF shall accept input for PCC decision-making from the PCEF, the BBERF if present, the TDF if present, the SPR and if the AF is involved, from the AF, as well as the PCRF may use its own predefined information. These different nodes should provide as much information as possible to the PCRF. At the same time, the information below describes examples of the information provided. Depending on the particular scenario all the information may not be available or is already provided to the PCRF.

3GPP TS 23.203 at 76.

The SPR may provide the following information for a subscriber, connecting to a specific PDN:

- Subscriber's allowed services, i.e. list of Service IDs;
- For each allowed service, a pre-emption priority;
- Information on subscriber's allowed QoS, including:
  - the Subscribed Guaranteed Bandwidth QoS;
  - a list of QoS class identifiers together with the MBR limit and, for real-time QoS class identifiers, GBR limit.
- Subscriber's charging related information;
- Spending limits profile containing an indication that policy decisions depend on policy counters available at the OCS that has a spending limit associated with it and optionally the list of relevant policy counters.
- Subscriber category;
- Subscriber's usage monitoring related information;
- Subscriber's profile configuration;
- Sponsored data connectivity profiles;
- MPS EPS Priority, MPS Priority Level (See TS 23.401 [17] for more detail on MPS Subscription);
- IMS Signalling Priority.

3GPP TS 23.203 at 77.

#### 6.2.2.4 QoS control

The PCEF enforces the authorized QoS for an IP-CAN bearer according to the information received via the Gx interface and depending on the bearer establishment mode.

Only the GBR per bearer is used for resource reservation (e.g. admission control in the RAN). The MBR (per PCC rule / per bearer) is used for rate policing.

For a UE-initiated IP-CAN bearer establishment or modification the PCEF receives the authorized QoS (QCI, ARP, GBR, MBR) for a bearer that the PCEF has identified for the PCRF. The PCEF shall enforce it which may lead to a downgrading or upgrading of the requested bearer QoS.

NOTE 1: The MBR is an average value, which is measured over some time period. Services may generate media with variable bitrate. For example, TS 26.114 [45] describes the bitrate variations that may be generated for real-time conversational media in the MTSS service. The policing function in the PCEF should take such bitrate variations into account.

For a network initiated IP-CAN bearer establishment or modification the PCEF receives the authorized QoS per PCC rule (QCI, ARP, GBR, MBR). For GBR bearers the PCEF should set the bearer's GBR to the sum of the GBRs of all PCC rules that are active and bound to that GBR bearer. If a set of PCC Rules is subject to resource sharing as specified in clause 6.1.14 the PCEF should use, for each applicable direction, the highest GBR from the set of PCC Rules sharing resources as input for calculating the bearer's GBR. For GBR bearers the PCEF should set the bearer's MBR to the sum of the MBRs of all PCC rules that are active and bound to that GBR bearer. If a set of PCC Rules is subject to resource sharing as specified in clause 6.1.14 the PCEF may, for each applicable direction, use the highest MBR from the set of PCC Rules as input for calculating the bearer's MBR.

3GPP TS 23.203 at 91-92.

The PCRF uses PCC rules to implement its policies and prioritizations.

## 6.3 Policy and charging control rule

### 6.3.1 General

The Policy and charging control rule (PCC rule) comprises the information that is required to enable the user plane detection of, the policy control and proper charging for a service data flow. The packets detected by applying the service data flow template of a PCC rule form a service data flow.

Two different types of PCC rules exist: Dynamic rules and predefined rules. The dynamic PCC rules are provisioned by the PCRF via the Gx reference point, while the predefined PCC rules are directly provisioned into the PCEF and only referenced by the PCRF. The usage of predefined PCC rules for QoS control is possible if the BBF remains in the PCEF during the lifetime of an IP-CAN session. In addition, predefined PCC rules may be used in a non-roaming situation and if it can be guaranteed that corresponding predefined QoS rules are configured in the BBF and activated along with the predefined PCC rules.

NOTE 1: The procedure for provisioning predefined PCC rules is out of scope for this specification.

NOTE 2: There may be another type of predefined rules that are not explicitly known in the PCRF and not under the control of the PCRF. The operator may define such predefined PCC rules, to be activated by the PCEF on one IP-CAN bearer within the IP-CAN session. The PCEF may only activate such predefined PCC rules if there is no UE provided traffic mapping information related to that IP-CAN bearer. The IP-CAN session termination procedure deactivates such predefined PCC rules.

There are defined procedures for activation, modification and deactivation of PCC rules (as described in clause 6.3.2). The PCRF may activate, modify and deactivate a PCC rule at any time, over the Gx reference point. However, the modification procedure is applicable to dynamic PCC rules only.

3GPP TS 23.203 at 99; *see also id.* at 100-104 (detailing the PCC rule information).

These PCC rules include Allocation and Retention Priority (ARP) characteristics that can be used to prioritize sessions.

### 6.1.7.3 Allocation and Retention Priority characteristics

The QoS parameter ARP contains information about the priority level, the pre-emption capability and the pre-emption vulnerability. The priority level defines the relative importance of a resource request. This allows deciding whether a bearer establishment or modification request can be accepted or needs to be rejected in case of resource limitations (typically used for admission control of GBR traffic). It can also be used to decide which existing bearers to pre-empt during resource limitations.

NOTE 1: The ARP priority level can be used in addition to the QCI to determine the transport level packet marking, e.g. to set the DiffServ Code Point of the associated EPS bearer, as described in TS 23.401 [17].

NOTE 2: When required by operator policy, the eNodeB can be configured to use the ARP priority level in addition to QCI priority level to control the packet forwarding treatment for SDFs having high priority ARPs.

The range of the ARP priority level is 1 to 15 with 1 as the highest level of priority. The pre-emption capability information defines whether a service data flow can get resources that were already assigned to another service data flow with a lower priority level. The pre-emption vulnerability information defines whether a service data flow can lose the resources assigned to it in order to admit a service data flow with higher priority level. The pre-emption capability and the pre-emption vulnerability can be either set to 'yes' or 'no'.

The ARP priority levels 1-8 should only be assigned to resources for services that are authorized to receive prioritized treatment within an operator domain (i.e. that are authorized by the serving network). The ARP priority levels 9-15 may be assigned to resources that are authorized by the home network and thus applicable when a UE is roaming.

NOTE 3: This ensures that future releases may use ARP priority level 1-8 to indicate e.g. emergency and other priority services within an operator domain in a backward compatible manner. This does not prevent the use of ARP priority level 1-8 in roaming situation in case appropriate roaming agreements exist that ensure a compatible use of these priority levels.

3GPP TS 23.203 at 56.

In addition to the use of 4G PCC architecture referenced above, the AT&T network adopts an analogous PCC framework from the 3GPP Standards for its 5G mobile network, which describe the prioritization of services to certain UEs based on billing profiles and billing history information. For example, the PCF can receive information from various sources as inputs to build PCC rules that affect the provision of services to UEs. *See, e.g.*, 3GPP TS 23.503 at 48 (service prioritization and conflict handling); *id.* at 63-66 (input for PCC decisions); *id.* at 6.2.2.4 (QoS control); *id.* at 76-84 (detailing PCC rules).

<p><b>1[E]</b> repeating:</p>	<p>Implementing AT&amp;T’s Broadband Internet Access Services repeats steps 1[F], 1[G], 1[H], and 1[L] below.</p> <p>As noted above, AT&amp;T repeats its network management process as available network capacity changes and as devices move into and out of a cell site.</p> <ul style="list-style-type: none"><li>• “Customers subject to Congestion-based Data Management will experience reduced speeds and increased latency only when they use data at a cell site experiencing network congestion at the same moment. As soon as the congestion at the cell site abates, or if the customer’s session migrates to an uncongested cell site, speeds and latency are not affected.” (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li></ul> <p>AT&amp;T explains that under certain plans, it may “temporarily slow data speeds if the network is busy.”</p>
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The screenshot displays three AT&T wireless plans side-by-side. The first plan, 'AT&T UNLIMITED ELITE® PLAN', is priced at \$50/mo. per line and includes HBO Max™ and 5G access. The second plan, 'AT&T UNLIMITED EXTRA® PLAN', is priced at \$40/mo. per line and includes 5G access. The third plan, 'AT&T UNLIMITED STARTER® PLAN', is priced at \$35/mo. per line and includes 5G access. All plans offer unlimited talk, text, and data, with varying data speeds and hotspot allowances. A 'Get started' button and a link to 'Learn more about Unlimited Your Way™' are at the bottom.

<https://www.att.com/plans/wireless/>

**1[F]** receiving traffic profiles over said network resource for said plurality of devices;

Implementing AT&T's Broadband Internet Access Services requires receiving traffic profiles (*e.g.*, data volumes, data rates, and/or content being carried over the network resource from devices sharing the resource) over AT&T's cellular network. For example, the network management considers the traffic load of the network resource for the plurality of devices running over that network resource to determine if the network is congested:

- “*Customers subject to Congestion-based Data Management* will experience reduced speeds and increased latency only when they use data at a *cell site experiencing network congestion at the same moment*. As soon as the congestion at the cell site abates, or if the customer's

	<p>session migrates to an uncongested cell site, speeds and latency are not affected.”  <a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</p> <ul style="list-style-type: none"> <li>• “Mobile Services. <i>Service performance may be affected by</i> your proximity to a cell site, the capacity of the cell site, the technology at the cell site, <i>the number of other users connected to the same cell site and the services they are using</i>, the surrounding terrain, use inside a building or a moving vehicle, radio frequency interference, <i>your mobile data plan</i>, the capabilities of your device, applicable network management practices as discussed on this page, and the applications you use. In addition, AT&amp;T has designed its wireless services to provide our customers with a high-quality voice experience during simultaneous voice and data sessions, which may affect data performance, including but not limited to a temporary reduction in speed to minimize the likelihood of dropped calls.”  <a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</li> </ul> <p>The 3GPP Standards describe the use of the PCC architecture in AT&amp;T’s operator network and other network elements to transmit and receive traffic-related information.</p>
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	<p>The PCC architecture shall support topology hiding.</p> <p>It should be possible to use PCC architecture for handling IMS-based emergency service and Restricted Local Operator Services.</p> <p>It shall be possible with the PCC architecture, in real-time, to monitor the overall amount of resources that are consumed by a user and to control usage independently from charging mechanisms, the so-called usage monitoring control.</p> <p>It shall be possible for the PCC architecture to provide application awareness even when there is no explicit service level signalling.</p> <p>The PCC architecture shall support making policy decisions based on subscriber spending limits.</p> <p>The PCC architecture shall support making policy decisions based on RAN user plane congestion status.</p> <p>The PCC architecture shall support making policy decisions for multi-access IP flow mobility solution described in TS 23.161 [43].</p> <p>The PCC architecture shall support making policy decisions for (S)Gi-LAN traffic steering.</p>
	<p>3GPP TS 23.203 at 21.</p> <p>For instance, the Rx reference point provides session level information to the PCRF.</p>

### 5.2.1 Rx reference point

The Rx reference point resides between the AF and the PCRF.

NOTE 1: The AF may be a third party application server.

This reference point enables transport of application level session information from AF to PCRF. Such information includes, but is not limited to:

- IP filter information to identify the service data flow for policy control and/or differentiated charging;
- Media/application bandwidth requirements for QoS control.
- In addition, for sponsored data connectivity:
  - the sponsor's identification,
  - optionally, a usage threshold and whether the PCRF reports these events to the AF,
  - information identifying the application service provider and application (e.g. SDFs, application identifier, etc.).

The Rx reference point enables the AF subscription to notifications on IP-CAN bearer level events (e.g. signalling path status of AF session) in the IP-CAN.

3GPP TS 23.203 at 31.

As another example, the AF provides traffic profile information to the PCRF.

For policy control, the AF interacts with the PCRF and the PCRF interacts with the PCEF as instructed by the AF. For certain events related to policy control, the AF shall be able to give instructions to the PCRF to act on its own, i.e. based on the service information currently available. The following events are subject to instructions from the AF:

- The authorization of the service based on incomplete service information:

NOTE 1: The QoS authorization based on incomplete service information is required for e.g. IMS session setup scenarios with available resources on originating side and a need for resource reservation on terminating side.

- The immediate authorization of the service;
- The gate control (i.e. whether there is a common gate handling per AF session or an individual gate handling per AF session component required);
- The forwarding of IP-CAN bearer level information or events:
  - Type of IP-CAN (e.g. GPRS, etc.);
  - Transmission resource status (established/released/lost);
  - Access Network Charging Correlation Information;
  - Credit denied.

NOTE 2: The credit denied information is only relevant for AFs not performing service charging.

To enable the binding functionality, the UE and the AF shall provide all available flow description information (e.g. source and destination IP address and port numbers and the protocol information). The UE shall use the traffic mapping information to indicate downlink and uplink IP flows.

3GPP TS 23.203 at 48.

The AF, if involved, may provide the following application session related information, e.g. based on SIP and SDP:

- Subscriber Identifier;
- IP address of the UE;
- Media Type;
- Media Format, e.g. media format sub-field of the media announcement and all other parameter information (a= lines) associated with the media format;
- Bandwidth;
- Sponsored data connectivity information (see clause 5.2.1);
- Flow description, e.g. source and destination IP address and port numbers and the protocol;

3GPP TS 23.203 at 77-78.

The PCEF also provides usage monitoring to the PCRF.

The PCEF shall support usage monitoring as specified in clause 4.4.

The PCEF enhanced with ADC shall handle application traffic detection as per request from PCRF as well as report about the detected application traffic along with service data flow descriptions, if deducible, to the PCRF, if requested by the PCRF.

3GPP TS 23.203 at 86.

Event triggers also provide traffic profile information to the PCRF.

### 6.1.4 Event Triggers

The Event Reporting Function (ERF) performs event trigger detection. When an event matching the event trigger occurs, the ERF shall report the occurred event to the PCRF. The Event Reporting Function is located either at the PCEF or, at the BBERF (if applicable) or, at the TDF for solicited application reporting (if applicable).

The event triggers define the conditions when the ERF shall interact again with PCRF after an IP-CAN session establishment. The event triggers that are required in procedures shall be unconditionally reported from the ERF, while the PCRF may subscribe to the remaining events. Whether an event trigger requires a subscription by the PCRF is indicated in column 4 in table 6.2 below.

The PCRF subscribes to new event triggers or remove armed event triggers unsolicited at any time or upon receiving a request from the AF, an event report or rule request from the ERF (PCEF or BBERF or TDF) using the Provision of PCC Rules procedure or the Provision of QoS Rules procedure (if applicable) or the Provision of ADC Rules procedure (if applicable). If the provided event triggers are associated with certain parameter values then the ERF shall include those values in the response back to the PCRF. Event triggers are associated with all rules at the ERF of an IP-CAN session (ERF is located at PCEF) or Gateway Control session (ERF is located at BBERF) or with Traffic Detection session (ERF is located in TDF). Event triggers determine when the ERF shall signal to the PCRF that an IP-CAN bearer has been modified. It shall be possible for the ERF to react on the event triggers listed in table 6.2.

3GPP TS 23.203 at 42. For instance, the following event triggers are available:

Information			
Usage report (see note 7)	The IP-CAN session or the Monitoring key specific resources consumed by a UE either reached the threshold or needs to be reported for other reasons.	PCEF, TDF	PCRF
Start of application traffic detection and Stop of application traffic detection (see note 8)	The start or the stop of application traffic has been detected.	PCEF, TDF	PCRF

3GPP TS 23.203 at 44.

Additionally, the Traffic Detection Function provides traffic profile information.

## 6.2.9 Traffic Detection Function (TDF)

### 6.2.9.1 General

The TDF is a functional entity that performs application detection and reporting of detected application and its service data flow description to the PCRF. The TDF supports solicited application reporting and/or unsolicited application reporting. The application detection filter may be extended with the PFDs provided by the PFDF as described in clause 6.1.20. The new PFDs provided by the PFDF replace the existing ones in the PCEF.

3GPP TS 23.203 at 96.

Further, the Np reference point provides congestion information to the PCRF.

## 5.2.12 Np reference point

The Np reference point resides between the RCAF and the PCRF.

The Np reference point enables transport of RAN User Plane Congestion Information (RUCI) sent from the RCAF to the PCRF for all or selected subscribers, depending on the operator's congestion mitigation policy.

The Np reference point supports the following functions:

- Reporting of RUCI from the RCAF to the PCRF.
- Sending, updating and removal of the reporting restrictions from the PCRF to the RCAF as defined in clause 6.1.15.2.

3GPP TS 23.203 at 34.

The RCAF provides congestion-related information, including traffic profile information, to the PCRF so it can account for that information in making its policy decisions.

### 4.3.1 RCAF

The RCAF is a functional element which reports RAN User Plane Congestion Information (RUCI) via the Np interface to the PCRF to enable the PCRF to take the RAN user plane congestion status into account for policy decisions. RUCI includes the following information:

- The user id (e.g. IMSI) identifying the UE impacted by congestion;
- PDN ID for which congestion information is reported;
- Congestion level information (either congestion level value or congestion level set id) of the UE impacted by congestion;
- eNodeB identifier, ECGI or SAI identifying the eNodeB, E-UTRAN cell or Service Area respectively, serving the UE if a conditional restriction to restrict location reporting is not enabled.

NOTE 1: In case of E-UTRAN, whether the eNodeB identifier or the ECGI are included in the RUCI is up to operator configuration in the RCAF.

3GPP TS 29.217 version 16.0.0 Release 16, at 8 (2020-08).

## 4.2 Np reference model

The relationships between the involved functional entities are depicted in figure 4.2.1. The overall PCC architecture is depicted in clause 3a of 3GPP TS 29.213 [3] .

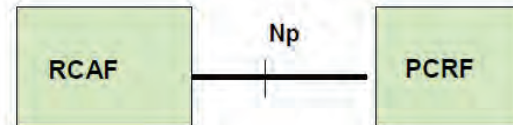


Figure 4.2.1: Np reference model

3GPP TS 29.217 version 16.0.0 Release 16, at 8 (2020-08).

### 4.3.2 PCRF

The PCRF is a functional element that encompasses policy control decision and flow based charging control functionalities.

The PCRF may receive RUCI from the RCAF as input for policy decisions of congestion mitigation. The PCRF may provide, update or remove the reporting restrictions of RUCI, or stop or enable RUCI reporting for a given user id and PDN ID. The PCRF may enable or disable the reporting of congestion location identifier as part of RUCI. The PCRF may also remove the context at the RCAF for a given user id and PDN ID.

3GPP TS 29.217 version 16.0.0 Release 16, at 9 (2020-08)

**RAN user plane congestion:** RAN user plane congestion occurs when the demand for RAN resources exceeds the available RAN capacity to deliver the user data for a prolonged period of time.

3GPP TS 23.203 at 18. “The PCRF can receive RAN User Plane Congestion Information from the RAN Congestion Awareness Function (RCAF).” *Id.* at 28.

The congestion information is provided over the Np reference point.

## 4.4 Procedures over Np reference point

### 4.4.1 RUCI Report

#### 4.4.1.1 General

The RCAF shall perform the RUCI reporting to the PCRF when at least one of the following conditions applies:

- the RCAF detects a UE in the congestion area for the first time;
- a reporting restriction is enabled and the congestion level set id is changed;

3GPP TS 29.217 version 16.0.0 Release 16, at 9 (2020-08).

### 6.1.15 Reporting of RAN user plane congestion information

#### 6.1.15.1 General

RAN User Plane Congestion Information (RUCI) is reported to the PCRF to enable the PCRF to take the RAN user plane congestion status into account for policy decisions.

The RUCI includes the following information:

- The IMSI identifying the UE impacted by congestion;
- eNB identifier, ECGI or SAI identifying the eNB, E-UTRAN cell or Service Area, respectively, serving the UE.

NOTE: Whether in case of E-UTRAN the eNB identifier or the ECGI is included in the RUCI is up to operator configuration in the RCAF.

- APN for which congestion information is reported;
- Congestion level or an indication of the "no congestion" state.

#### 6.1.15.2 Reporting restrictions

Depending on the operator's congestion mitigation policy, it may not be necessary to have RUCI reporting for all users. An operator shall be able to specify restrictions for RUCI reporting on a per UE per APN basis. Reporting restrictions can be used to activate or deactivate the RUCI reporting. Reporting restrictions can also be used to limit RUCI reporting. This is achieved by defining one or more sets of congestion levels, such that the RCAF indicates only that the UE experiences a congestion level within the given set but does not indicate the congestion level itself within that set.

3GPP TS 23.203 at 62.

### 6.1.15.3 UE mobility between RCAFs

A RCAF is assumed to serve a geographical area. A UE may move from the area handled by one RCAF to an area handled by a different RCAF. RCAF nodes cannot detect mobility by themselves: an RCAF node cannot differentiate whether a UE that is no longer affected by congestion has moved to another RCAF or not. When a given RCAF indicates no congestion to the PCRF for a given UE on the Np interface, this should be interpreted as no congestion experienced at the given RCAF which does not exclude that another RCAF may report that the same UE experiences congestion.

Consistent operation for UE mobility is ensured by applying the following rules at the PCRF.

- The PCRF maintains the RCAF which has last indicated that the UE is affected by congestion.
- When a new RCAF indicates that the UE is affected by congestion, the PCRF sends a message to the old RCAF to explicitly release context at the old RCAF.

3GPP TS 23.203 at 63.

### 4.4.12 RAN Congestion Awareness Function

The RAN Congestion Awareness Function (RCAF) is an element that provides RAN User Plane Congestion Information (RUCI) to the PCRF to enable the PCRF to take the RAN user plane congestion status into account for policy decisions.

The RCAF collects information related to user plane congestion from the RAN's OAM system based on which the RCAF determines the congestion level (and the identifier) of an eNodeB or E-UTRAN cell.

Via the Nq interface the RCAF determines the UEs served by a congested eNodeB or congested E-UTRAN cell and retrieves the APNs of the active PDN connections of those UEs. The decision whether the RCAF operates on eNodeB or E-UTRAN cell level is up to operator configuration.

Via the Np reference point, the RCAF sends the RUCI to the PCRFs serving the UEs' PDN connections.

3GPP TS 23.401 at 96-97.

	<p>In addition to the use of 4G PCC architecture referenced above, the AT&amp;T operator network adopts the analogous PCC framework from the 3GPP Standards for its 5G mobile network, thereby implementing a method for receiving traffic profiles over said network resource for said plurality of devices. <i>See, e.g.,</i> 3GPP TS 23.503 at 13 (“It shall be possible with the PCC framework, in real-time, to monitor the overall amount of resources that are consumed by a user and to control usage independently from charging mechanisms, the so-called usage monitoring control.”); <i>id.</i> at 21 (interactions between PCF and AF); <i>id.</i> at 26 (policy decisions based on network analytics); <i>id.</i> at 33 and 46 (application traffic detection); <i>id.</i> at 47-48 (policy control based on interface between the PCF, SMF, and AF); <i>id.</i> at 65-67 (PCC decisions receive input from AF and NWDAF).</p>
<p><b>1[G]</b> managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,</p>	<p>AT&amp;T’s Broadband Internet Access Services manages said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles. Implementing AT&amp;T’s Broadband Internet Access Services requires managing the network resource when the requests for data at a location are significant enough to affect network performance. Further, the network management considers the data regulation and specific data plan for the devices:</p> <ul style="list-style-type: none"> <li>• “<b><i>Customers subject to Congestion-based Data Management</i></b> will experience reduced speeds and increased latency only when they use data at a <b><i>cell site experiencing network congestion at the same moment</i></b>. As soon as the congestion at the cell site abates, or if the customer’s session migrates to an uncongested cell site, speeds and latency are not affected.” (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> <li>• “Mobile Services. <b><i>Service performance may be affected by</i></b> your proximity to a cell site, the capacity of the cell site, the technology at the cell site, <b><i>the number of other users connected to the same cell site and the services they are using</i></b>, the surrounding terrain, use inside a building or a moving vehicle, radio frequency interference, <b><i>your mobile data plan</i></b>, the capabilities of your device, applicable network management practices as discussed on this page, and the applications you use. In addition, AT&amp;T has designed its wireless services to provide our customers with a high-quality voice experience during simultaneous voice and data sessions, which may affect data performance, including but not limited to a temporary reduction in speed to minimize the likelihood of dropped calls.” (<a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</li> </ul>

AT&T's network management takes into account the customer's billing profile and the localized demand for a particular network resource:

- “Congestion-based Data Management. One network management practice we use to manage our wireless network resources *may affect customers with most AT&T post-paid and AT&T PREPAID<sup>SM</sup> unlimited mobile data plans (“AT&T Unlimited Data Plans”). During periods of congestion*, these customers may experience reduced data speeds and increased latency as *compared to other customers using the same cell site* (“Congestion-based Data Management”). *Depending on the customer's AT&T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan* (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans.” (<https://about.att.com/sites/broadband/network>)

AT&T advertises that under certain wireless plans, “AT&T may temporarily slow data speeds if the network is busy.” The service profile for a particular user will impact whether their broadband access speed is reduced (sometimes after a certain data threshold is reached):

The screenshot displays three AT&T Unlimited plans side-by-side. Each plan includes a list of features and a 'Get started' button at the bottom.

Plan Name	Price (per line)	Key Features
AT&T UNLIMITED ELITE® PLAN	\$50 /mo. per line (when you get 4 lines)	<ul style="list-style-type: none"> <li>Unlimited talk, text, &amp; high-speed data that can't slow down based on how much you use</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® advanced security (including spam &amp; fraud call blocking, identity monitoring, safe browsing, and more)</li> <li>40GB Hotspot data per line per month</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>4K UHD streaming available</li> <li>HBO Max™ included</li> <li>Stadia Pro—6 months of streaming gaming on us</li> <li>Signature Program members save up to \$10/mo. per line through your work or organization</li> </ul>
AT&T UNLIMITED EXTRA® PLAN	\$40 /mo. per line (when you get 4 lines)	<ul style="list-style-type: none"> <li>Unlimited talk, text, data + 50GB of Premium Data (After 50GB, AT&amp;T may temporarily slow data speeds if the network is busy)</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® advanced security (including spam &amp; fraud call blocking, identity monitoring, safe browsing, and more)</li> <li>15GB Hotspot data per line per month</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>Standard-definition streaming</li> <li>Stadia Pro—6 months of streaming gaming on us</li> </ul>
AT&T UNLIMITED STARTER® PLAN	\$35 /mo. per line (when you get 4 lines)	<ul style="list-style-type: none"> <li>Unlimited talk, text &amp; data (AT&amp;T may temporarily slow data speeds if the network is busy)</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® security (including spam &amp; fraud call blocking, and more)</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>Standard-definition streaming</li> <li>Stadia Pro—6 months of streaming gaming on us</li> </ul>

<https://www.att.com/plans/wireless/>

The 3GPP Standards describe the use of the PCC architecture in AT&T's operator network and other network elements to enforce policy decisions, thereby managing network resources according to service-related and billing-related information set forth in Claims 1[B] and 1[C], as well as traffic-related information set forth in Claim 1[D].

As one example, a PCRF or PCEF may manage a network resource by initiating a IP-CAN modification in response to specific event triggers relating to the network resource.

#### 6.1.4 Event Triggers

The Event Reporting Function (ERF) performs event trigger detection. When an event matching the event trigger occurs, the ERF shall report the occurred event to the PCRF. The Event Reporting Function is located either at the PCEF or, at the BBERF (if applicable) or, at the TDF for solicited application reporting (if applicable).

The event triggers define the conditions when the ERF shall interact again with PCRF after an IP-CAN session establishment. The event triggers that are required in procedures shall be unconditionally reported from the ERF, while the PCRF may subscribe to the remaining events. Whether an event trigger requires a subscription by the PCRF is indicated in column 4 in table 6.2 below.

The PCRF subscribes to new event triggers or remove armed event triggers unsolicited at any time or upon receiving a request from the AF, an event report or rule request from the ERF (PCEF or BBERF or TDF) using the Provision of PCC Rules procedure or the Provision of QoS Rules procedure (if applicable) or the Provision of ADC Rules procedure (if applicable). If the provided event triggers are associated with certain parameter values then the ERF shall include those values in the response back to the PCRF. Event triggers are associated with all rules at the ERF of an IP-CAN session (ERF is located at PCEF) or Gateway Control session (ERF is located at BBERF) or with Traffic Detection session (ERF is located in TDF). Event triggers determine when the ERF shall signal to the PCRF that an IP-CAN bearer has been modified. It shall be possible for the ERF to react on the event triggers listed in table 6.2.

3GPP TS 23.203 at 42.

Network management can be performed, for instance, based on IP-CAN session modification.

## 7.4 IP-CAN Session Modification

### 7.4.1 IP-CAN Session Modification; GW (PCEF) initiated

This clause describes the signalling flow for the IP-CAN Session modification initiated by the GW (PCEF). These modifications include IP-CAN bearer establishment and termination as well as modification if the triggering conditions given to the PCEF are fulfilled.

For the PCEF enhanced with ADC, the reason for such a modification may be that a start or stop of application traffic that matches with one of the activated PCC Rules is detected.

The AF may be involved. An example of the scenario is authorization of a session-based service for which an IP-CAN Session is also modified.

3GPP TS 23.203 at 137; *see generally id.* at 137-144 (describing PCEF and PCRF initiated session modification).

Additionally, network management at the PCRF can be performed, for example, based on information received regarding congestion.

## 4.3.24 RAN user plane congestion management function

### 4.3.24.1 General

The user plane congestion management function addresses how the system can effectively mitigate RAN user plane congestion in order to reduce the negative impact on the perceived service quality. The congestion mitigation measures include traffic prioritization, traffic reduction and limitation of traffic, and shall be able to manage user plane traffic across a range of variables including the user's subscription, the type of application, and the type of content. Congestion mitigation can be performed in the RAN or in the CN, or in a combined way both in the RAN and in the CN.

3GPP TS 23.401 at 82.

#### 4.3.24.3 RAN user plane congestion mitigation in the CN

RAN user plane congestion mitigation in the CN uses RAN OAM information, collected by the RAN Congestion Awareness Function (RCAF), to detect congestion. The RAN Congestion Awareness Function is further described in clause 4.4.12. This functionality is applicable only in the case of UTRAN/E-UTRAN accesses.

NOTE 1: The criteria used for detection of RAN user plane congestion (including detection of congestion abatement) are outside the scope of 3GPP specifications.

NOTE 2: The interface to the RAN's OAM system is not standardized.

The RCAF can transfer RAN user plane congestion information (RUCI) to the PCRF over the Np reference point in order to mitigate the congestion by measures selected by the PCRF, as specified in TS 23.203 [6]. Decisions to apply congestion mitigation measures may take into account operator policies and subscriber information and all additional available IP-CAN session information.

Different mechanisms and mitigation actions applicable as described in TS 23.203 [6] in order to mitigate RAN User Plane Congestion. Those mechanisms include e.g. service/application gating, service/application bandwidth limitation, deferring of services.

NOTE 3: Co-existence between congestion mitigation in RAN and CN can be assured by appropriate network configuration of applicable policies for congestion mitigation, as well as related RAN parameter alignment/tuning, such as tuning of parameters for e.g., load balancing, carrier aggregation, co-ordinated multipoint, dual connectivity. This parameter alignment/tuning is not further specified.

NOTE 4: A condition leading to interoperability issues which may lead to suboptimal situation is that the time scales for actions of congestion mitigation in RAN and in CN are of comparable duration. Therefore, congestion mitigation in RAN and CN cannot have comparable time scales, otherwise interoperability is affected.

3GPP TS 23.401 at 83.

*See also* 1[F] (detailing the RCAF reporting).

The PCC architecture makes policy decisions based on subscriber information and traffic profile information.

	<div data-bbox="636 224 1860 651" style="border: 1px solid black; padding: 10px;"> <p>It shall be possible with the PCC architecture, in real-time, to monitor the overall amount of resources that are consumed by a user and to control usage independently from charging mechanisms, the so-called usage monitoring control.</p> <p>It shall be possible for the PCC architecture to provide application awareness even when there is no explicit service level signalling.</p> <p>The PCC architecture shall support making policy decisions based on subscriber spending limits.</p> <p>The PCC architecture shall support making policy decisions based on RAN user plane congestion status.</p> <p>The PCC architecture shall support making policy decisions for multi-access IP flow mobility solution described in TS 23.161 [43].</p> <p>The PCC architecture shall support making policy decisions for (S)Gi-LAN traffic steering.</p> </div> <p>3GPP TS 23.203 at 21.</p> <p>In addition to the use of 4G PCC architecture referenced above, the AT&amp;T network adopts the analogous PCC framework from the 3GPP Standards for its 5G mobile network to support control of PDU Sessions, thereby implementing a method for managing network resources according to service-related and billing-related information set forth in Claims 1[B] and 1[C], as well as traffic-related information set forth in Claim 1[F]. <i>See, e.g.</i>, 3GPP TS 23.503 at 15-16 (QoS control requirements); <i>id.</i> at 71-74 (QoS control and PDU Session modification at SMF based on usage monitoring).</p>
<p><b>1[H]</b> selecting at least one of said devices based on said prioritization list and</p>	<p>AT&amp;T's Broadband Internet Access Services selects at least one of said devices based on said prioritization list. Implementing AT&amp;T's Broadband Internet Access Services requires selecting at least one of the devices for prioritization.</p> <p><i>See</i> limitation 1[D] above regarding prioritization lists and using prioritization list to limit data rates of specific AT&amp;T customers.</p> <ul style="list-style-type: none"> <li>• “Congestion-based Data Management. One network management practice we use to manage our wireless network resources may affect customers with most AT&amp;T post-paid and AT&amp;T PREPAID<sup>SM</sup> unlimited mobile data plans (“AT&amp;T Unlimited Data Plans”). During periods of congestion, <i>these customers may experience reduced data speeds and increased latency as compared to other customers using the same cell site</i> (“Congestion-based Data Management”). Depending on the customer's AT&amp;T Unlimited Data Plan, they will either always experience</li> </ul>

Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans.” (<https://about.att.com/sites/broadband/network>)

AT&T advertises that certain data plans may have their data rates slowed as compared to other data plans, which involves a selection:

The screenshot displays three AT&T Unlimited Data Plans side-by-side. Each plan includes a price per line, a list of features, and a 'Get started' button at the bottom.

Plan Name	Price /mo. per line (when you get 4 lines)	Key Features
AT&T UNLIMITED ELITE® PLAN	\$50	<ul style="list-style-type: none"> <li>Unlimited talk, text, &amp; high-speed data that can't slow down based on how much you use</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® advanced security (including spam &amp; fraud call blocking, identity monitoring, safe browsing, and more)</li> <li>40GB Hotspot data per line per month</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>4K UHD streaming available</li> <li>HBO Max™ included</li> <li>Stadia Pro—6 months of streaming gaming on us</li> <li>Signature Program members save up to \$10/mo. per line through your work or organization</li> </ul>
AT&T UNLIMITED EXTRA® PLAN	\$40	<ul style="list-style-type: none"> <li>Unlimited talk, text, data + 50GB of Premium Data (After 50GB, AT&amp;T may temporarily slow data speeds if the network is busy)</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® advanced security (including spam &amp; fraud call blocking, identity monitoring, safe browsing, and more)</li> <li>15GB Hotspot data per line per month</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>SD Standard-definition streaming</li> <li>Stadia Pro—6 months of streaming gaming on us</li> </ul>
AT&T UNLIMITED STARTER® PLAN	\$35	<ul style="list-style-type: none"> <li>Unlimited talk, text &amp; data (AT&amp;T may temporarily slow data speeds if the network is busy)</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® security (including spam &amp; fraud call blocking, and more)</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>SD Standard-definition streaming</li> <li>Stadia Pro—6 months of streaming gaming on us</li> </ul>

At the bottom of the screenshot, there is a 'Get started' button and a link: 'Learn more about Unlimited Your Way™'.

<https://www.att.com/plans/wireless/>

	<ul style="list-style-type: none"> <li>• “Mobile Services. <i>Service performance may be affected by</i> your proximity to a cell site, the capacity of the cell site, the technology at the cell site, <i>the number of other users connected to the same cell site and the services they are using</i>, the surrounding terrain, use inside a building or a moving vehicle, radio frequency interference, <i>your mobile data plan</i>, the capabilities of your device, applicable network management practices as discussed on this page, and the applications you use. In addition, AT&amp;T has designed its wireless services to provide our customers with a high-quality voice experience during simultaneous voice and data sessions, which may affect data performance, including but not limited to a temporary reduction in speed to minimize the likelihood of dropped calls.” (<a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</li> </ul>
<p><b>1[I]</b> dynamically modifying at least one of said service profile and said billing profile for said selected devices, if said network resource is under-utilized by said traffic profile or if said network resource would be over-utilized by said traffic profiles;</p>	<p>AT&amp;T’s Broadband Internet Access Services dynamically modifies at least one of said service profile and said billing profile for said selected devices, if said network resource is under-utilized by said traffic profile or if said network resource would be over-utilized by said traffic profiles.</p> <p>Implementing AT&amp;T’s Broadband Internet Access Services requires dynamically modifying at least the service profile(s) by adjusting the data speeds when the resource is over utilized by the customer’s data requests:</p> <ul style="list-style-type: none"> <li>• In addition, <i>this network management practice adjusts dynamically to address the amount of congestion</i>, which can start and stop over a very short time period (often measured in fractions of a second), further minimizing any customer impact. Because the amount of congestion at a cell site can vary significantly, the performance impact for affected AT&amp;T Unlimited Data Plan customers may also vary significantly, but such impact will last only as long as the site is congested. (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> </ul> <p>AT&amp;T explains that it “may temporarily slow your speed at any time if our network is busy.” AT&amp;T adjusts data bit-rates of customers (which comprises part of the customer’s service profile) according</p>

to a customer's Rate Plan and/or when a customer exceeds the data volume caps of a customer's Data Plan:

- "If a lot of devices are using mobile data at once, it can put a strain in our network. This is called network congestion, and we may have to slow your data speed to keep everyone connected. On an unlimited plan? *We may temporarily slow your speed at any time if our network is busy.* We may also slow it after you use more than 50GB or 22GB of data in a single bill period." (<https://www.att.com/help/wireless/data-usage/>)

The PCRF makes control decisions that result in modifying a service profile and or billing profile.

## 6.2.1 Policy Control and Charging Rules Function (PCRF)

### 6.2.1.0 General

The PCRF encompasses policy control decision and flow based charging control functionalities.

The PCRF provides network control regarding the service data flow detection, gating, QoS and flow based charging (except credit management) towards the PCEF and/or TDF.

The PCRF provides network control regarding the application detection, gating, QoS and application based charging (except credit management) towards the TDF and the PCEF enhanced with ADC.

The PCRF shall apply the security procedures, as required by the operator, before accepting service information from the AF.

The PCRF shall decide whether application traffic detection is applicable, as per operator policies, based on user profile configuration, received within subscription information.

The PCRF shall decide how certain service/application traffic shall be treated in the PCEF and in the TDF, if applicable, and ensure that the PCEF user plane traffic mapping and treatment is in accordance with the user's subscription profile.

If Gxx applies, the PCRF shall provide QoS rules with identical service data flow templates as provided to the PCEF in the PCC rules. If the service data flow is tunnelled at the BBERF, the PCRF shall provide the BBERF with information received from the PCEF to enable the service data flow detection in the mobility tunnel at the BBERF. In case 2a,

3GPP TS 23.203 at 71.

The PCRF may check that the service information provided by the AF is consistent with both the operator defined policy rules and the related subscription information as received from the SPR during IP-CAN session establishment before storing the service information. The service information shall be used to derive the QoS for the service. The PCRF may reject the request received from the AF when the service information is not consistent with either the related subscription information or the operator defined policy rules and as a result the PCRF shall indicate that this service information is not covered by the subscription information or by operator defined policy rules and may indicate, in the response to the AF, the service information that can be accepted by the PCRF (e.g. the acceptable bandwidth). In the absence of other policy control mechanisms outside the scope of PCC, it is recommended that the PCRF include this information in the response.

3GPP TS 23.203 at 72.

Such dynamic modifications may be based on, for example, a dynamic PCC rule, policy control, QoS class identifier, and/or subscribed guaranteed bandwidth QoS.

**dynamic PCC Rule:** a PCC rule, for which the definition is provided to the PCEF via the Gx reference point.

**policy control:** The process whereby the PCRF indicates to the PCEF how to control the IP-CAN bearer. Policy control includes QoS control and/or gating control.

**QoS class identifier (QCI):** A scalar that is used as a reference to a specific packet forwarding behaviour (e.g. packet loss rate, packet delay budget) to be provided to a SDF. This may be implemented in the access network by the QCI referencing node specific parameters that control packet forwarding treatment (e.g. scheduling weights, admission thresholds, queue management thresholds, link layer protocol configuration, etc.), that have been pre-configured by the operator at a specific node(s) (e.g. eNodeB).

**subscribed guaranteed bandwidth QoS:** The per subscriber, authorized cumulative guaranteed bandwidth QoS which is provided by the SPR/UDR to the PCRF.

3GPP TS 23.203 at 17-18.

The PCC architecture shall allow the charging control to be applied on a per service data flow and on a per application basis, independent of the policy control.

The PCC architecture shall have a binding method that allows the unique association between service data flows and their IP-CAN bearer.

A single service data flow detection shall suffice for the purpose of both policy control and flow based charging.

A PCC rule may be predefined or dynamically provisioned at establishment and during the lifetime of an IP-CAN session. The latter is referred to as a dynamic PCC rule.

The number of real-time PCC interactions shall be minimized although not significantly increasing the overall system reaction time. This requires optimized interfaces between the PCC nodes.

It shall be possible to take a PCC rule into service, and out of service, at a specific time of day, without any PCC interaction at that point in time.

It shall be possible to take APN-related policy information into service, and out of service, once validity conditions specified as part of the APN-related policy information are fulfilled or not fulfilled anymore, respectively, without any PCC interaction at that point in time.

PCC shall be enabled on a per PDN basis (represented by an access point and the configured range of IP addresses) at the PCEF. It shall be possible for the operator to configure the PCC architecture to perform charging control, policy control or both for a PDN access.

PCC shall support roaming users.

The PCC architecture shall allow the resolution of conflicts which would otherwise cause a subscriber's Subscribed Guaranteed Bandwidth QoS to be exceeded.

3GPP TS 23.203 at 20.

	<div><p>The PCC architecture shall support topology hiding.</p><p>It should be possible to use PCC architecture for handling IMS-based emergency service and Restricted Local Operator Services.</p><p>It shall be possible with the PCC architecture, in real-time, to monitor the overall amount of resources that are consumed by a user and to control usage independently from charging mechanisms, the so-called usage monitoring control.</p><p>It shall be possible for the PCC architecture to provide application awareness even when there is no explicit service level signalling.</p><p>The PCC architecture shall support making policy decisions based on subscriber spending limits.</p><p>The PCC architecture shall support making policy decisions based on RAN user plane congestion status.</p><p>The PCC architecture shall support making policy decisions for multi-access IP flow mobility solution described in TS 23.161 [43].</p><p>The PCC architecture shall support making policy decisions for (S)Gi-LAN traffic steering.</p></div> <p>3GPP TS 23.203 at 21.</p> <p>The PCRF implements dynamic policy decisions.</p>
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#### 4.4 Usage Monitoring Control

It shall be possible to apply usage monitoring for the accumulated usage of network resources on a per IP-CAN session and user basis. This capability is required for enforcing dynamic policy decisions based on the total network usage in real-time.

The PCRF that uses usage monitoring for making dynamic policy decisions shall set and send the applicable thresholds to the PCEF or TDF for monitoring. The usage monitoring thresholds shall be based either on time, or on volume. The PCRF may send both thresholds to the PCEF or TDF. The PCEF or TDF shall notify the PCRF when a threshold is reached and report the accumulated usage since the last report for usage monitoring. If both time and volume thresholds were provided to the PCEF or TDF, the accumulated usage since last report shall be reported when either the time or the volume thresholds are reached.

NOTE: There are reasons other than reaching a threshold that may cause the PCEF/TDF to report accumulated usage to the PCRF as defined in clauses 6.2.2.3 and 6.6.2.

The usage monitoring capability shall be possible for an individual or a group of service data flow(s), or for all traffic of an IP-CAN session in the PCEF. When usage monitoring for all traffic of an IP-CAN session is enabled, it shall be possible to exclude an individual SDF or a group of service data flow(s) from the usage monitoring for all traffic of this IP-CAN session. It shall be possible to activate usage monitoring both to service data flows associated with predefined PCC rules and dynamic PCC rules, including rules with deferred activation and/or deactivation times while those rules are active.

3GPP TS 23.203 at 25.

### 5.2.2 Gx reference point

The Gx reference point resides between the PCEF and the PCRF.

The Gx reference point enables the PCRF to have dynamic control over the PCC behaviour at a PCEF.

The Gx reference point enables the signalling of PCC decision, which governs the PCC behaviour, and it supports the following functions:

- Establishment of Gx session (corresponding to an IP-CAN session) by the PCEF;
- Request for PCC decision from the PCEF to the PCRF;
- Provision of IP flow mobility routing information from PCEF to PCRF; this applies only when IP flow mobility as defined in TS 23.261 [23] is supported;
- Provision of PCC decision from the PCRF to the PCEF;
- Reporting of the start and the stop of detected applications and transfer of service data flow descriptions and application instance identifiers for detected applications from the PCEF to the PCRF;
- Reporting of the accumulated usage of network resources on a per IP-CAN session basis from the PCEF to the PCRF;
- Delivery of IP-CAN session specific parameters from the PCEF to the PCRF or, if Gxx is deployed, from the PCRF to the PCEF per corresponding request;
- Negotiation of IP-CAN bearer establishment mode (UE-only or UE/NW);
- Termination of Gx session (corresponding to an IP-CAN session) by the PCEF or the PCRF.

3GPP TS 23.203 at 31.

	<p>The enforcement of the authorized QoS of the IP-CAN bearer may lead to a downgrading or upgrading of the requested bearer QoS by the GW (PCEF) as part of a UE-initiated IP-CAN bearer establishment or modification. Alternatively, the enforcement of the authorised QoS may, depending on operator policy and network capabilities, lead to network initiated IP-CAN bearer establishment or modification. If the PCRF provides authorized QoS for both, the IP-CAN bearer and PCC rule(s), the enforcement of authorized QoS of the individual PCC rules shall take place first.</p> <p>QoS authorization information may be dynamically provisioned by the PCRF or, if the conditions mentioned in clause 6.3.1 apply, it can be a predefined PCC rule in the PCEF. In case the PCRF provides PCC rules dynamically, authorised QoS information for the IP-CAN bearer (combined QoS) may be provided. For a predefined PCC rules within the PCEF the authorized QoS information shall take affect when the PCC rule is activated. The PCEF shall combine the different sets of authorized QoS information, i.e. the information received from the PCRF and the information corresponding to the predefined PCC rules. The PCRF shall know the authorized QoS information of the predefined PCC rules and shall take this information into account when activating them. This ensures that the combined authorized QoS of a set of PCC rules that are activated by the PCRF is within the limitations given by the subscription and operator policies regardless of whether these PCC rules are dynamically provided, predefined or both.</p> <p>3GPP TS 23.203 at 48.</p> <p>In addition to the use of 4G PCC architecture referenced above, the AT&amp;T network adopts an analogous PCC framework from the 3GPP Standards for its 5G mobile network, thereby implementing a method for dynamically modifying at least one of said service profile and said billing profile for said selected devices, if said network resource is under-utilized by said traffic profile or if said network resource would be over-utilized by said traffic profiles. <i>See, e.g.</i>, 3GPP TS 23.503 at 17; <i>see also, e.g.</i>, 3GPP TS 23.503 at 9 (authorized QoS flow, dynamic PCC rule, PCC decision, policy control, and subscribed guaranteed bandwidth QoS for 5G systems); <i>id.</i> at 60-62 (Policy Control Function); <i>id.</i> at 66-69 (Policy control subscription information management describing changes in subscription information); <i>id.</i> at 78-84, 88-89 (modification of dynamic PCC rules).</p>
<p><b>1[J]</b> until said plurality of devices no longer continue to share said network resource; and</p>	<p>AT&amp;T's Broadband Internet Access Services repeats the steps 1[F]-1[I] until said plurality of devices no longer continue to share said network resource. Implementing AT&amp;T's Broadband Internet Access Services requires prioritizing the data traffic by repeating 1[F]-1[I] until the plurality of devices no longer continue to share said network resource (i.e., until that network resource is no longer congested).</p> <ul style="list-style-type: none"> <li>• "Customers subject to Congestion-based Data Management will experience reduced speeds and increased latency only when they use data at a cell site experiencing network congestion at the same moment. <i>As soon as the congestion at the cell site abates, or if the customer's session</i></li> </ul>

	<p><i>migrates to an uncongested cell site, speeds and latency are not affected.”</i>  <a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</p> <p>As part of congestion reporting (<i>see</i> 1[F]), “the RCAF detects that the UE is no longer experiencing congestion (i.e. the UE is no longer detected in any of the congested cells that the RCAF is monitoring).” 3GPP TS 29.217 version 16.0.0 Release 16, at 10 (2020-08).</p> <p>The PCRF maintains session information until it is terminated.</p> <div data-bbox="617 477 1860 880" style="border: 1px solid black; padding: 10px;"> <p><b>6.2.1.2 Subscription information management in the PCRF</b></p> <p>The PCRF may request subscription information from the SPR for an IP-CAN session at establishment or a gateway control session at establishment. The subscription information may include user profile configuration indicating whether application detection and control should be enabled. The PCRF should specify the subscriber ID and, if available, the PDN identifier in the request. <b>The PCRF should retain the subscription information that is relevant for PCC decisions until the IP-CAN session termination and the gateway control session termination.</b></p> <p>The PCRF may request notifications from the SPR on changes in the subscription information. Upon reception of a notification, the PCRF shall make the PCC decisions necessary to accommodate the change in the subscription and updates the PCEF and/or the BBERF and/or the TDF by providing the new PCC and/or QoS and/or ADC decisions if needed. The PCRF shall send a cancellation notification request to the SPR when the related subscription information has been deleted.</p> </div> <p>3GPP TS 23.203 at 79; <i>see also id.</i> at 132, 135 (detailing IP-CAN Session Termination).</p>
<p><b>1[K]</b> when said plurality of devices are no longer sharing said network resource, clearing said prioritization list.</p>	<p>AT&amp;T’s Broadband Internet Access Services clears said prioritization list when said plurality of devices are no longer sharing said network resource.</p> <p>Implementing AT&amp;T’s Broadband Internet Access Services includes clearing the prioritization list when the plurality of devices are no longer sharing the network resource (<i>i.e.</i>, the prioritization list is not generated when there is no traffic over a network resource or the amount of traffic falls below a certain threshold).</p> <ul style="list-style-type: none"> <li>• “Customers subject to Congestion-based Data Management will experience reduced speeds and increased latency only when they use data at a cell site experiencing network congestion at the same moment. <i>As soon as the congestion at the cell site abates, or if the customer’s session migrates to an uncongested cell site, speeds and latency are not affected.”</i>  <a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> </ul>

	<p>AT&amp;T explains that a reduction in speed is “temporary” and can change in “fractions of a second.”</p> <ul style="list-style-type: none"> <li>• “If a lot of devices are using mobile data at once, it can put a strain in our network. This is called network congestion, and we may have to slow your data speed to keep everyone connected. On an unlimited plan? <b><i>We may temporarily slow your speed at any time if our network is busy.</i></b> We may also slow it after you use more than 50GB or 22GB of data in a single bill period.” (<a href="https://www.att.com/help/wireless/data-usage/">https://www.att.com/help/wireless/data-usage/</a>)</li> <li>• In addition, this network management practice adjusts dynamically to address the amount of congestion, <b><i>which can start and stop over a very short time period (often measured in fractions of a second)</i></b>, further minimizing any customer impact. Because the amount of congestion at a cell site can vary significantly, the performance impact for affected AT&amp;T Unlimited Data Plan customers may also vary significantly, but such impact will last only as long as the site is congested. (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> <li>• “In addition, like the other networks that make up the internet, the AT&amp;T network is a shared network, which means that the transmission links and other network resources used to provide broadband services are shared among AT&amp;T’s subscribers, as well as among the various services offered by AT&amp;T. <b><i>Temporary congestion may occur</i></b> when a large number of customers in a concentrated area access the network at the same time or when some customers consume a very large amount of network capacity during busy periods, such as at stadium events, during peak usage times, or during planned network maintenance.” (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> </ul> <p>The PCRF maintains session information until it is terminated.</p>
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#### 6.2.1.2 Subscription information management in the PCRF

The PCRF may request subscription information from the SPR for an IP-CAN session at establishment or a gateway control session at establishment. The subscription information may include user profile configuration indicating whether application detection and control should be enabled. The PCRF should specify the subscriber ID and, if available, the PDN identifier in the request. The PCRF should retain the subscription information that is relevant for PCC decisions until the IP-CAN session termination and the gateway control session termination.

The PCRF may request notifications from the SPR on changes in the subscription information. Upon reception of a notification, the PCRF shall make the PCC decisions necessary to accommodate the change in the subscription and updates the PCEF and/or the BBERF and/or the TDF by providing the new PCC and/or QoS and/or ADC decisions if needed. The PCRF shall send a cancellation notification request to the SPR when the related subscription information has been deleted.

3GPP TS 23.203 at 79; *see also id.* at 132, 135 (detailing IP-CAN Session Termination).

CLAIM 2	'813 PATENT V. AT&T
<p><b>2[A].</b> The method of claim 1 wherein said dynamically modifying comprises increasing or reducing an overall bit-rate cap or data volume cap in a service profile for at least one of said devices.</p>	<p>AT&amp;T's Broadband Internet Access Services provides for reducing the bit rate cap of data during times of congestion on the network (and potentially increasing the bit rate cap once the congestion clears).</p> <p><i>See</i> 1[I] (explaining that the network management “may temporarily slow your speed”), which is incorporated here by reference.</p> <p>As noted above in Claim 1, the AT&amp;T cellular network modifies a customer's bit rate cap when data volume caps are exceeded during a monthly billing cycle. AT&amp;T explains that speed reductions (i.e., the bit rate of certain users is capped) occur in the AT&amp;T network, especially during periods of network congestion.</p> <p>AT&amp;T explains that a reduction in speed is “temporary” and can change in “fractions of a second.”</p> <ul style="list-style-type: none"> <li>• “If a lot of devices are using mobile data at once, it can put a strain in our network. This is called network congestion, and we may have to slow your data speed to keep everyone connected. On an unlimited plan? <i>We may temporarily slow your speed at any time if our network is busy.</i> We may also slow it after you use more than 50GB or 22GB of data in a single bill period.” (<a href="https://www.att.com/help/wireless/data-usage/">https://www.att.com/help/wireless/data-usage/</a>)</li> <li>• In addition, this network management practice adjusts dynamically to address the amount of congestion, <i>which can start and stop over a very short time period (often measured in fractions of a second)</i>, further minimizing any customer impact. Because the amount of congestion at a cell site can vary significantly, the performance impact for affected AT&amp;T Unlimited Data Plan customers may also vary significantly, but such impact will last only as long as the site is congested. (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> <li>• “In addition, like the other networks that make up the internet, the AT&amp;T network is a shared network, which means that the transmission links and other network resources used to provide broadband services are shared among AT&amp;T's subscribers, as well as among the various services offered by AT&amp;T. <i>Temporary congestion may occur</i> when a large number of</li> </ul>

	<p>customers in a concentrated area access the network at the same time or when some customers consume a very large amount of network capacity during busy periods, such as at stadium events, during peak usage times, or during planned network maintenance.” (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</p> <ul style="list-style-type: none"><li>• “Customers subject to Congestion-based Data Management will experience reduced speeds and increased latency only when they use data at a cell site experiencing network congestion at the same moment. <i>As soon as the congestion at the cell site abates, or if the customer’s session migrates to an uncongested cell site, speeds and latency are not affected.</i>” (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li></ul>
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CLAIM 4	'813 PATENT V. AT&T
<p><b>4[A].</b> The method of claim 1 wherein one of said devices at a first end of said list is a first device to be subject to said dynamically modifying if said network resource would be under-utilized by said traffic profiles.</p>	<p>On information and belief, AT&amp;T's implementation of dynamic allocation of network resources includes performing the dynamically modifying step on a first device at a first end of the prioritization list if said network resource would be under-utilized by said traffic profiles.</p> <p>Lists are often processed from one end to the other. Further discovery is necessary regarding the manner in which AT&amp;T creates, implements, and uses its prioritization list, as well as the manner in which customer's bit rates and/or data caps are adjusted during various network loading conditions.</p>

CLAIM 5	'813 PATENT V. AT&T
<p><b>5[A].</b> The method of claim 4 wherein said dynamically modifying comprises increasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list.</p>	<p>On information and belief, AT&amp;T's implementation of dynamic allocation of network resources includes increasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list.</p> <p>Further discovery is necessary regarding the manner in which AT&amp;T creates, implements, and uses its prioritization list, as well as the manner in which customer's bit rates and/or data caps are adjusted during various network loading conditions.</p>

CLAIM 6	'813 PATENT V. AT&T
<b>6[A].</b> The method of claim 5 wherein said increasing fully utilizes a remainder of a capacity of said network resource.	<p>On information and belief, AT&amp;T's implementation of dynamic allocation of network resources includes increasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list wherein said increasing fully utilizes a remainder of a capacity of said network resource.</p> <p>Further discovery is necessary regarding the manner in which AT&amp;T creates, implements, and uses its prioritization list, as well as the manner in which customer's bit rates and/or data caps are adjusted during various network loading conditions.</p>

CLAIM 7	'813 PATENT V. AT&T
<p>7[A]. The method of claim 1 wherein one of said devices at a first end of said list is a first device to be subject to said dynamically modifying if said network resource would be over-utilized by said traffic profiles.</p>	<p>On information and belief, AT&amp;T's implementation of dynamic allocation of network resources includes performing the dynamically modifying step on a first device at a first end of the prioritization list if said network resource would be over-utilized by said traffic profiles.</p> <p>Lists are often processed from one end to the other. Further discovery is necessary regarding the manner in which AT&amp;T creates, implements, and uses its prioritization list, as well as the manner in which customer's bit rates and/or data caps are adjusted during various network loading conditions.</p> <p>See the explanation and evidence provided relative to limitations 1[B] and 2[A], which are incorporated by reference here.</p> <ul style="list-style-type: none"> <li>• <i>“Depending on the customer’s AT&amp;T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&amp;T Unlimited Data Plan (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&amp;T Unlimited Data Plans.”</i>  <a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a></li> </ul> <p>The AT&amp;T network prioritizes users based upon the Rate Plans they have selected and based upon whether customers have exceeded a monthly data volume cap. For example, AT&amp;T's Unlimited Extra Plan “may temporarily slow data speeds if the network is busy” if the customer exceeds 50GB of data in a particular month:</p>

The screenshot displays three AT&T Unlimited plans side-by-side. The 'Elite' plan on the left is priced at \$50/mo. per line and includes HBO Max and 5G access. The 'Extra' plan in the middle is \$40/mo. per line and includes 5G access. The 'Starter' plan on the right is \$35/mo. per line and includes 5G access. All plans offer unlimited talk, text, and data, with varying data speeds and hotspot allowances. A 'Get started' button is visible at the bottom center of the plan cards.

Plan Name	Price	Key Features
AT&T UNLIMITED ELITE® PLAN	\$50 /mo. per line	Unlimited talk, text, & high-speed data; 5G access; AT&T ActiveArmor security; 40GB Hotspot data; Unlimited talk, text and data in Mexico & Canada; Unlimited texting from U.S. to 200+ countries; 4K UHD streaming; HBO Max included; Stadia Pro—6 months of streaming gaming on us; Signature Program members save up to \$10/mo.
AT&T UNLIMITED EXTRA® PLAN	\$40 /mo. per line	Unlimited talk, text, data + 50GB of Premium Data; 5G access; AT&T ActiveArmor security; 15GB Hotspot data; Unlimited talk, text and data in Mexico & Canada; Unlimited texting from U.S. to 200+ countries; Standard-definition streaming; Stadia Pro—6 months of streaming gaming on us.
AT&T UNLIMITED STARTER® PLAN	\$35 /mo. per line	Unlimited talk, text & data; 5G access; AT&T ActiveArmor security; Unlimited talk, text and data in Mexico & Canada; Unlimited texting from U.S. to 200+ countries; Standard-definition streaming; Stadia Pro—6 months of streaming gaming on us.

<https://www.att.com/plans/wireless/>

AT&T describes this process in its Service Agreement:

- “Reduced data throughput speeds apply when using Data Services at times and in areas experiencing network congestion compared to other customers using the same cell site. Standard speeds will resume once the cell site is no longer congested or when your data session moves to an uncongested cell site, and *speeds will no longer be reduced during periods of network congestion at the start of your next billing period, unless your usage again exceeds an applicable, identified data usage threshold for that next billing period.*” (<https://www.att.com/legal/terms.consumerServiceAgreement.html>)

CLAIM 8	'813 PATENT V. AT&T
<p><b>8[A].</b> The method of claim 7 wherein said dynamically modifying comprises decreasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list.</p>	<p>On information and belief, AT&amp;T's implementation of dynamic allocation of network resources includes decreasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list.</p> <p>Further discovery is necessary regarding the manner in which AT&amp;T creates, implements, and uses its prioritization list, as well as the manner in which customer's bit rates and/or data caps are adjusted during various network loading conditions.</p>

CLAIM 9	'813 PATENT V. AT&T
<p>9[A]. The method of claim 8 wherein said decreasing brings said traffic profiles into alignment with full utilization of a capacity of said network resource.</p>	<p>On information and belief, AT&amp;T's implementation of dynamic allocation of network resources includes decreasing an overall bit-rate cap or data volume cap for said one of said devices at said first end of said list wherein said decreasing brings said traffic profiles into alignment with full utilization of a capacity of said network resource.</p> <p>AT&amp;T implements various "Congestion-based Data Management" techniques to manage the allocation of network resources. AT&amp;T explains that "this network management practice adjusts dynamically to address the amount of congestion."</p> <ul style="list-style-type: none"> <li>• In addition, <i>this network management practice adjusts dynamically to address the amount of congestion</i>, which can start and stop over a very short time period (often measured in fractions of a second), further minimizing any customer impact. Because the amount of congestion at a cell site can vary significantly, the performance impact for affected AT&amp;T Unlimited Data Plan customers may also vary significantly, but such impact will last only as long as the site is congested. (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> </ul> <p>AT&amp;T explains that when "a lot of devices are using mobile data at once, it can put a strain on our network," and "we may have to slow your data speed to keep everyone connected."</p> <ul style="list-style-type: none"> <li>• "If a lot of devices are using mobile data at once, it can put a strain in our network. <i>This is called network congestion, and we may have to slow your data speed to keep everyone connected.</i> On an unlimited plan? We may temporarily slow your speed at any time if our network is busy. We may also slow it after you use more than 50GB or 22GB of data in a single bill period." (<a href="https://www.att.com/help/wireless/data-usage/">https://www.att.com/help/wireless/data-usage/</a>)</li> </ul> <p>See Claims 2 and 7, which are incorporated by reference here.</p> <p>Further discovery is necessary regarding the manner in which AT&amp;T creates, implements, and uses its prioritization list, as well as the manner in which customer's bit rates and/or data caps are adjusted during various network loading conditions.</p>

CLAIM 10	'813 PATENT V. AT&T
<p><b>10[A].</b> An apparatus for dynamic allocation of network resources comprising:</p>	<p>AT&amp;T provides network services to customers and, in doing so, uses an apparatus for dynamic allocation of network resources.</p> <p>AT&amp;T's network services provided to customers rely on server hardware/software and other specialized hardware/software to implement dynamic allocation of network resources, such as the network resources described by Claim 1. These hardware/software systems include, for example, OSS/BSS systems, base stations, RAN, 3G core, 4G core, and 5G core network elements. Exemplary hardware and software provided by AT&amp;T's suppliers to support the dynamic allocation of network resources are detailed below. Further discovery is required to particularly identify each hardware/software component implemented by AT&amp;T for dynamic allocation of network resources.</p> <p>AT&amp;T's Broadband Internet Access network services infrastructure comprises a series of wireless base stations and the systems that support those base stations. This infrastructure includes apparatuses for dynamic allocation of network resources. On information and belief, AT&amp;T uses hardware and/or software from third parties to implement portions of its network services. AT&amp;T's 4G LTE base station infrastructure and equipment is supplied by Alcatel-Lucent (now Nokia) and Ericsson. (<a href="https://www.computerworld.com/article/2520867/at-t-names-lte-suppliers-as-it-charges-into-battle-with-verizon.html">https://www.computerworld.com/article/2520867/at-t-names-lte-suppliers-as-it-charges-into-battle-with-verizon.html</a>); (<a href="https://www.networkworld.com/article/2244357/at-t-forges-4g-rollout-with-alcatel-lucent--ericsson.html">https://www.networkworld.com/article/2244357/at-t-forges-4g-rollout-with-alcatel-lucent--ericsson.html</a>): (<a href="https://telecoms.com/18112/ericsson-wins-lte-contract-with-att/">https://telecoms.com/18112/ericsson-wins-lte-contract-with-att/</a>); (<a href="https://venturebeat.com/2010/02/10/one-step-closer-to-4g-att-chooses-alcatel-lucent-and-ericsson-as-lte-equipment-suppliers/">https://venturebeat.com/2010/02/10/one-step-closer-to-4g-att-chooses-alcatel-lucent-and-ericsson-as-lte-equipment-suppliers/</a>). According to public literature, Ericsson supplies approximately 65% of AT&amp;T's 4G base station infrastructure and equipment. (<a href="https://telecomstechnews.com/news/2018/sep/26/samsung-nokia-ericsson-att-basestation/">https://telecomstechnews.com/news/2018/sep/26/samsung-nokia-ericsson-att-basestation/</a>) AT&amp;T's 5G base station infrastructure and equipment are supplied by Ericsson, Nokia, Samsung, and Amdocs. (<a href="https://about.att.com/story/2018/5g_cities_2018_2019.html">https://about.att.com/story/2018/5g_cities_2018_2019.html</a>); (<a href="https://www.nokia.com/about-us/news/releases/2021/06/10/nokia-and-att-accelerate-us-c-band-rollout-with-first-commercial-equipment-call/">https://www.nokia.com/about-us/news/releases/2021/06/10/nokia-and-att-accelerate-us-c-band-rollout-with-first-commercial-equipment-call/</a>); (<a href="https://www.ericsson.com/en/press-releases/2021/10/att-selects-ericsson-for-expansion-of-5g-network-and-c-band-spectrum-build">https://www.ericsson.com/en/press-releases/2021/10/att-selects-ericsson-for-expansion-of-5g-network-and-c-band-spectrum-build</a>).</p> <p>AT&amp;T's Broadband Internet Access Services includes the AT&amp;T Network, including the servers that implement the method referenced with regard to Claim 1 that support the dynamic allocation of shared</p>

network resources, including base stations or cell towers or the backhaul network used to route calls to and from the base stations or cell towers to the AT&T backend system as well as the components of the AT&T backend system that support that dynamic allocation of shared network resources.

On information and belief, service profile information is provided by the AT&T backend management systems, including but not limited to the AT&T Operating Support Systems (OSS) and business support systems (BSS) used to manage customer services and billing. In addition, on information and belief, AT&T implements a Service-Aware Policy Controller (SAPC) that is based on the 3GPP Policy and Charging Rules Function (PCRF) and Policy Control Function (PCF) to handle policy control and charging rules that define the services it supports. *See, e.g.,* (<https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/service-aware-policy-controller>); (<https://www.ericsson.com/en/press-releases/2021/10/att-selects-ericsson-for-expansion-of-5g-network-and-c-band-spectrum-build>); (<https://developer.att.com/technical-library/network-technologies/long-term-evolution>).

On information and belief, AT&T provides policy control (including PCRF and PCF) consistent with TS23.303, which includes the establishment of IP-CAN sessions, QoS control (Section 4.3.3), reference points to subscriber databases (Section 5.2.3), subscription information management in the PCRF (Section 6.2.1.2), a subscription profile repository (SPR) (Section 6.2.4), and a user data repository (UDR) (Section 6.2.8) *See* TS 23.203 at 24, 32, 69-70, 76, 91-93.

AT&T has described the PCF and PCRF in its 4G networks as the “functionality [that] enables traffic prioritization within the LTE gateways.”

- “LTE supports policy and charging control mechanisms initially introduced in Release 7. This functionality enables traffic prioritization within the LTE Gateways. The Policy and Charging Control (PCC) architecture has two major functional elements, the Policy and Charging Rules Function (PCRF) and the Policy and Charging Enforcement Function (PCEF). **The PCRF maintains the rules for network operations and filters the resource requests against policy rules and makes decisions about network performance. These rules and decisions are based on subscriber profiles.** PCEF enforces the policy decisions by prioritizing service data flow.” (<https://developer.att.com/technical-library/network-technologies/long-term-evolution>)

AT&T signed a five-year multi-billion-dollar agreement with Ericsson to support its 5G network rollout:

- “Building on more than 20 years of collaboration, Ericsson (NASDAQ: ERIC) and AT&T today announced a five-year agreement to accelerate the expansion of AT&T 5G. This deal helps support deployment of the service provider’s recently acquired C-band spectrum and the launch of 5G Standalone (SA). AT&T is tapping into Ericsson’s leading network expertise as the company works toward its 5G network goals.” (<https://www.ericsson.com/en/press-releases/2021/10/att-selects-ericsson-for-expansion-of-5g-network-and-c-band-spectrum-build>); *see also* (<https://telecoms.com/511698/att-signs-up-ericsson-for-rolling-out-5g-in-c-band/>).

AT&T uses equipment and software from the Ericsson Radio System portfolio to implement its 5G network:

- “AT&T’s network evolution is made possible in part by the Ericsson Radio System portfolio, which includes the Advanced Antenna System, Advanced RAN Coordination and Carrier Aggregation technologies.” (<https://www.ericsson.com/en/press-releases/2021/10/att-selects-ericsson-for-expansion-of-5g-network-and-c-band-spectrum-build>).

Part of Ericsson’s Radio System Software includes dynamic (demand-driven) spectrum sharing, which allows rapid allocation of spectrum depending on the needs of the base station resource at a given time.



...

	<div><p>Ericsson pioneered the creation of an ecosystem around the 3GPP-defined standards for Dynamic Spectrum Sharing. While delivering all the ecosystem's benefits, Ericsson Spectrum Sharing takes the technology even further. The unique Ericsson Spectrum Sharing scheduler enables rapid (per-millisecond) demand-driven spectrum allocation between 4G LTE and 5G NR. This maximizes spectrum efficiency and enables new low-latency use cases.</p><p>Ericsson Spectrum Sharing can be activated remotely through a software update in more than five million Ericsson Radio Systems already in service worldwide. Ericsson Spectrum Sharing has full eco-system support.</p></div> <p>(<a href="https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-software/ericsson-spectrum-sharing">https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-software/ericsson-spectrum-sharing</a>) (last visited 1/26/2022). Ericsson's shared carrier services provide similar on-demand allocation of network spectrum.</p>
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## Shared Carrier

With the continuously growing LTE capacity and coverage needs, operators want to introduce LTE in their existing GSM and WCDMA bands and are looking for ways to maximize the spectrum efficiency.

Ericsson Shared Carrier enables LTE and GSM or WCDMA overlapping in the same spectrum - with an automatic and instant use of spectrum based on the service needed.

The GSM or WCDMA transceivers are flexibly configured inside the LTE carrier. This maximizes LTE capacity within the operator's spectrum assets and can be done without compromising on voice services.

(<https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-solutions/shared-carrier>) (last visited 1/26/2022).

Ericsson's radio hardware includes and is controlled in part by Ericsson software.

# NR Radio Access Network

NR Radio Access Network brings the latest software for Ericsson Radio System 5G networks.

Ericsson's 5G NR RAN is part of Ericsson Radio System and a vital component of our 5G platform. NR RAN encloses a future-proof software offering, co-existing with LTE and smoothly integrating 5G NR.

Ericsson's NR RAN is built for multiple frequency bands and for the RAN Compute portfolio, supporting Non-standalone as well as Standalone deployments. NR RAN can be remotely installed on existing Ericsson Radio System radios.

(<https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-software/nr-radio-access-network>) (last visited 1/26/2022).

Ericsson's 5G software plugins "intelligently route data and users based on application requirements and device capabilities."

	<div data-bbox="762 207 1717 789"> <p>5G Plug-Ins include:</p> <ul style="list-style-type: none"> <li>• Massive MIMO and Multi-user MIMO: Combines MIMO with beamforming on advanced antennas to improve the user-experience, capacity, and coverage of the mobile network</li> <li>• Intelligent Connectivity: Increases the combined data throughput and coverage of 5G by enabling the network to intelligently route data and users based on application requirements and device capabilities</li> <li>• RAN Virtualization: Improves network efficiency and performance by enabling Virtual Network Functions (VNF) to be centralized on a common 4G / 5G platform</li> <li>• Latency Reduction: Reduces time to content while enabling real-time communications</li> </ul> </div> <p>(<a href="https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-software/5g-plug-ins">https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-software/5g-plug-ins</a>) (last visited 1/26/2022).</p> <p>Ericsson’s Orchestration capabilities provide a “dynamic approach to managing the service and the resource upon which they depend.”</p> <div data-bbox="762 1005 1717 1295"> <p><b>Use Your Resources Efficiently to Provide a Differentiated Experience</b></p> <p>In today’s information-driven marketplace, gaining a competitive edge takes a new level of agility that can only be reached through a more dynamic approach to managing the service and the resource upon which they depend. Choose Ericsson’s Orchestration solutions for unsurpassed flexibility, automation, usability and openness.</p> </div> <p>(<a href="https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-solutions/5g-ran-slicing-solution/automated-network-operations/orchestration">https://www.ericsson.com/en/portfolio/networks/ericsson-radio-system/radio-system-solutions/5g-ran-slicing-solution/automated-network-operations/orchestration</a>) (last visited 1/26/2022).</p>
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Ericsson's Cloud Core technologies include multiple policy-related offerings, such as the Cloud Core Policy Controller, Cloud Core Resource Controller, and Service-Aware Policy Controller.

## Cloud Core Policy Controller

**Cloud Core Policy Controller is the commercial realization of a centralized policy controller for 5G and legacy networks**

Cloud Core Policy Controller (CCPC) implements the centralized policy controller in the 5G network. It includes 3GPP PCF functionality plus a number of added value features. CCPC provides the tools to optimize the service delivery settings dynamically to fulfill the commercial service requirements and deliver the expected Quality of Experience.

CCPC includes different kind of policies: session-management policies, access policies, mobility policies and UE policies.

CCPC allows operators to deploy dual mode EPC/5GC policy control service resource selection (PCF/PCRF) with single O&M and orchestration.

(<https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/cloud-core-policy-controller>) (last visited 1/26/2022).

# Cloud Core Resource Controller

**Cloud Core Resource Controller is the commercial realization of the 3GPP Network Functions NSSF and NRF.**

Cloud Core Resource Controller (CCRC) provides resource control in the network in an automated way, where resources include NFs, NF services and slices, with the purpose to maximize efficiency and reduce OPEX (ease of use, automation) and CAPEX (cost effective network), via an efficient implementation of NSSF and NRF in a single cloud native product allowing easy interworking with EPC and via a number of added-value features beyond 3GPP standard.

(<https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/cloud-core-resource-controller>) (last visited 1/26/2022).

## Service-Aware Policy Controller

Based on the 3GPP Policy and Charging Rules Function (PCRF) and Policy Control Function (PCF), the Ericsson Service-Aware Policy Controller (SAPC) supports the increase of revenue through personalized services and the optimized utilization of network resources.

SAPC is responsible for the policy control and charging rules that define the services and applications supported in mobile, fixed, and converged networks. Key to securing network behavior when users access data services, SAPC performs a business-critical role in the monetization and differentiation of service provider mobile and converged broadband commercial packages.

(<https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/service-aware-policy-controller>) (last visited 1/26/2022).

The SAPC provides personalized service to consumers based on their service profile, billing profile, and/or billing history.

### Personalized service offering

**Personalized service offerings**, allowing service providers to easily launch creative offers based on a wide set of parameters (such as user profile, time of day, location, service type, charging characteristics, and so on) to increase service usage and establish stronger customer relationships as a result of better usability.

(<https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/service-aware-policy-controller>) (last visited 1/26/2022).

The SAPC also supports granular rules for controlling access to and use of network resources.

### Outstanding flexibility and usability

**Outstanding flexibility and usability**, leveraging SAPC as the most flexible engine on the market to benefit from a high level of programmability and a range of rules. (The use of policies per subscriber or subscriber groups, for example, allows service providers to easily customize their service access rules to match ever-changing market requirements)

(<https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/service-aware-policy-controller>) (last visited 1/26/2022). The SAPC components is an important part of Ericsson's broadband network solution.

#### **Benefits of Ericsson Service-Aware Policy Controller**

The SAPC product is an important component of our solutions for broadband networks, which include Evolved Packet Core (EPC), mobile telephony evolution with VoLTE and Wi-Fi calling, and BSS services, to name a few. SAPC is also a central piece of our dual-mode 5G Cloud Core solution.

(<https://www.ericsson.com/en/portfolio/digital-services/cloud-core/cloud-unified-data-management-and-policy/policy-control/service-aware-policy-controller>) (last visited 1/26/2022).

AT&T signed a five-year multi-billion-dollar agreement with Nokia to support its 5G network rollout. (<https://www.nokia.com/about-us/news/releases/2021/03/18/nokia-supports-5g-for-att-customers-with-five-year-c-band-deal/>); (<https://www.sdxcentral.com/articles/news/nokia-nabs-att-c-band-5g-contract/2021/03/>).

Nokia's Cloud RAN is a cloud-based solution for virtualizing the base station between radio and the core network. The RAN implementation permits "improved network performance" and "more flexible and agile networks."

## Start your transition to a cloud-based radio network

An open and programmable Radio Access Network (RAN) enables the introduction of new capabilities for the use of 5G networks. Together with virtualization and network automation, it is expected to result in significant improvements in the way Communications Service Providers (CSPs) manage their networks and deliver new services. Furthermore, it fosters innovation by supporting the introduction of advanced capabilities such as artificial intelligence (AI) and machine learning (ML).

Open and programmable RAN promises benefits such as:

- improved network performance,
- accelerated time-to market of new services and functions,
- more flexible and agile networks,
- CAPEX and OPEX efficiencies.

(<https://www.nokia.com/networks/cloud-ran/>) (last visited 1/26/2022).

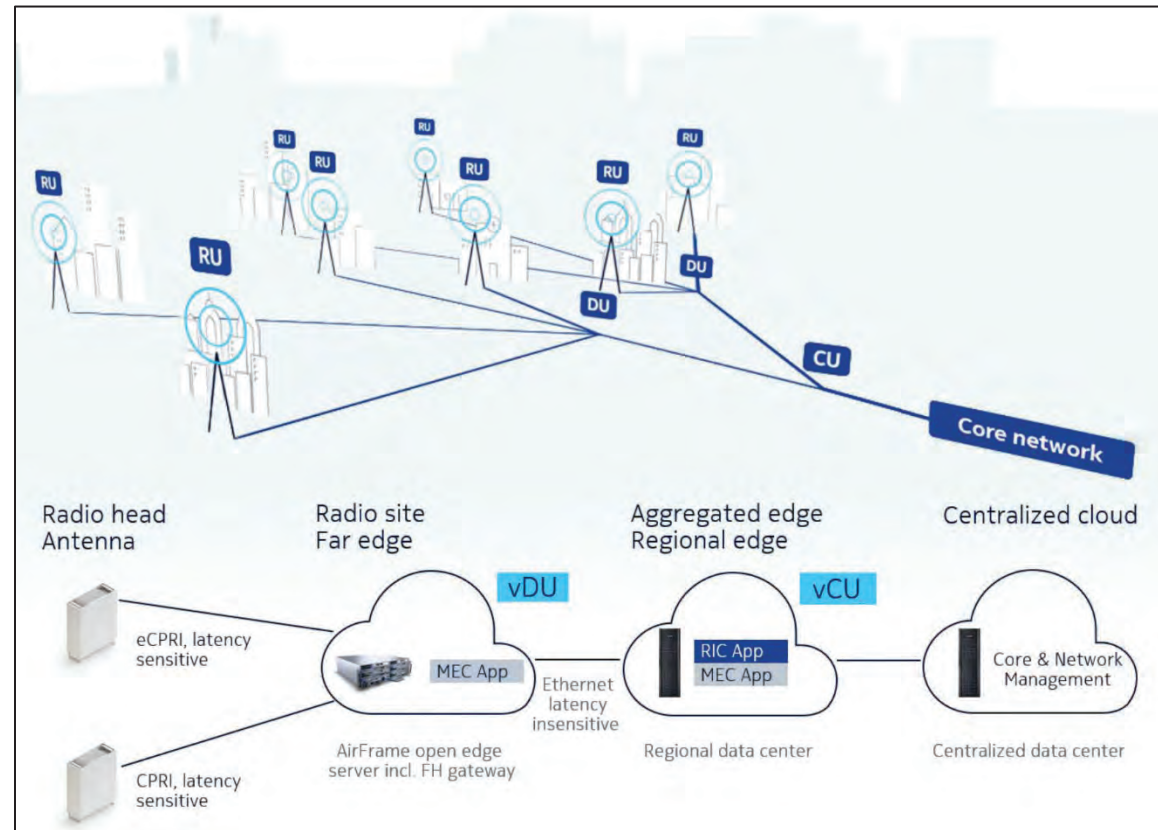
The Cloud RAN virtualizes the real-time and non-real time baseband into distributed units and centralized units.

Cloud RAN provides the flexibility to scale capacity at will, as well as launch and monetize services quickly and meet the required latency. Cloud RAN virtualizes baseband and decouples hardware and software, for them to have independent lifecycles.

In a fully cloudified Cloud RAN solution both the real-time and non-real-time baseband is virtualized and split into two separated functions:

- virtualized Distributed Unit (vDU),
- virtualized Centralized Unit (vCU).

(<https://www.nokia.com/networks/cloud-ran/>) (last visited 1/26/2022). The architecture for distributing the compute power implementing the Cloud RAN solution is illustrated below.



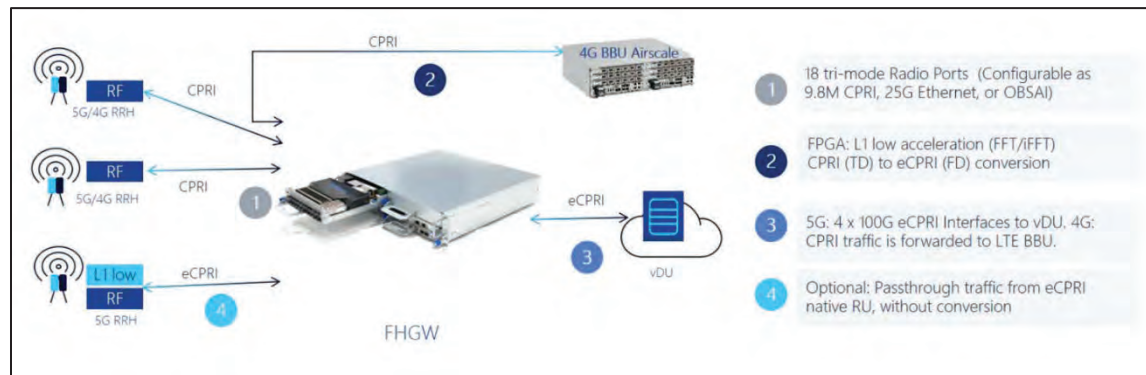
(<https://www.nokia.com/networks/cloud-ran/>) (last visited 1/26/2022).

Nokia provides an AirFrame data center solution that provides the AirFrame hardware for running cloud-based applications to support operator networks, such as AT&T's.

Nokia AirFrame data center solution is designed for running demanding virtualized and cloud-native software workloads. Security of the hardware and firmware is uncompromised and fulfills increased privacy and security needs for carrier grade networks. Enhancements including advanced packet, crypto, GPU and workload-specific FPGA acceleration make AirFrame to perform better than any traditional IT servers.

(<https://www.nokia.com/networks/solutions/airframe-data-center/>) (last visited 1/26/2022).

The Nokia AirFrame Fronthaul Gateway, illustrated below, “is a network element enabling operators to manage radio equipment connections.” (<https://www.nokia.com/networks/products/airframe-fronthaul-gateway>) (last visited 1/26/2022).



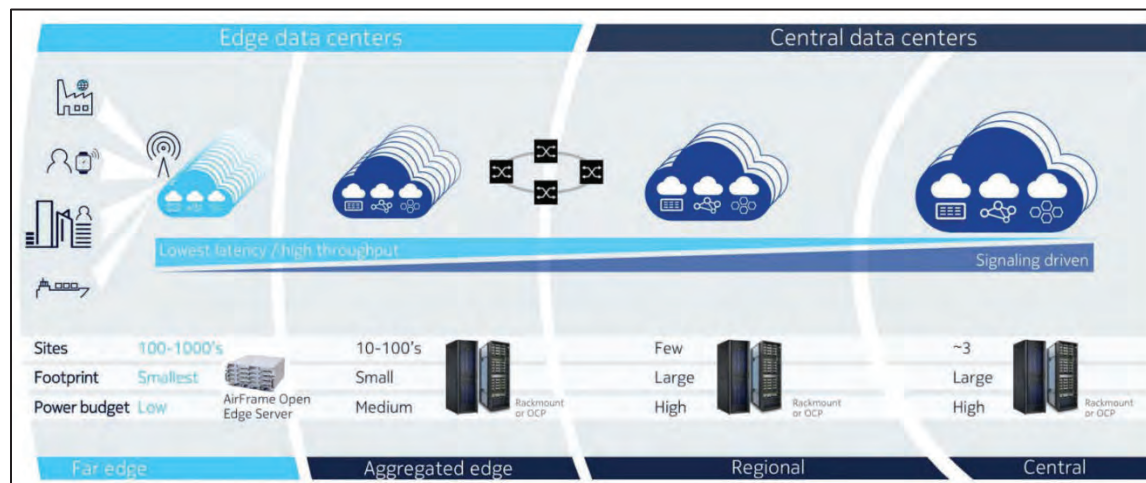
(<https://www.nokia.com/networks/products/airframe-fronthaul-gateway>) (last visited 1/26/2022).

Nokia also provides the AirFrame open edge server as hardware for use at edge locations, at or close to base station deployments.

AirFrame open edge server is fundamental to distributing computing capacity in the network and driving the implementation of Cloud RAN, Multi-access Edge Computing (MEC) as well as 5G.

The AirFrame Open Edge server chassis is only 3U high, enabling its installation on existing base station sites. It also has an acceleration capabilities for Cloud-RAN, Machine Learning/Artificial Intelligence and other workloads.

(<https://www.nokia.com/networks/products/airframe-open-edge-server/>) (last visited 1/26/2022). The far edge location, ideal for the open edge server, is illustrated below.



(<https://www.nokia.com/networks/products/airframe-open-edge-server/>) (last visited 1/26/2022).

Nokia's Agile Rules Technology (A.R.T.) is used in both 4G and 5G networks. Part of the A.R.T. is the PCF and PCRF. Nokia explains that the PCRF "enables service providers to map business demands and network constraints to easy-to-manage network policy rules." Agile Rules Technology paper at 8.

Nokia explains that the PCF and PCRF can be used by carriers to allocate network resources.

- “Another benefit to rule profiles is the ability to make provisioning easier for rules common to a feature. In the case of a “ThresholdProfile”, it’s possible for a user to assign various thresholds for a bucket or counter. **For example, a user can provision a 25% recurring threshold to send a usage notification to the subscriber, and a 50% threshold that reduces the quality of service for the remainder of a 2GB bucket.** Rather than creating several rules for sending notifications at the 25%, 50%, 75% and 100% thresholds, and an additional rule for changing the QoS once the 50% threshold is reached, the user can simply specify the percentages and recurrence values in the threshold object itself. From these values, the system generates the underlying rule groups, and assigns the appropriate actions. Not only does the provisioning of thresholds become easier, users can also add additional conditions in a standard rules format. For instance, it’s possible to add a condition to only send a 25% threshold notification if the subscriber is not roaming. The recurring threshold is still defined as 25% and the relevant rules is generated; however, in this example, it is combined with the additional condition of ‘not roaming.’” Agile Rules Technology paper at 9.

On information and believe, AT&T also uses software and hardware from Amdocs to support its 5G network. (<https://www.amdocs.com/news-press/att-selects-amdocs-support-its-business-support-systems-evolution-make-life-easier>); (<https://www.amdocs.com/news-press/att-selects-amdocs-power-5g-monetization>); ([https://about.att.com/story/2019/att\\_amdocs.html](https://about.att.com/story/2019/att_amdocs.html)); (<https://www.amdocs.com/sites/default/files/2021-07/amdocs-openet-policy-controller-global-data-3-mar21.pdf>).

Amdocs’ Virtual Policy Controller can fulfill the role of the PCRF.

- “The solution fulfils the role of the policy and charging rules function (PCRF) as defined in the 3GPP PCC Architecture (23.203 standard). Furthermore, as a key element of the evolved packet core (EPC), it determines policy rules in real time, based on interactions with other network functions, subscriber databases, charging systems, network conditions and other session context information.” (<https://www.amdocs.com/sites/default/files/2019-04/virtual-policy-controller-solution-brief.pdf>).

The Virtual Policy Controller allows for the dynamic allocation of network resources:

- “Amdocs Virtual Policy Controller enables CSPs to rapidly introduce high-value subscriber services that **leverage real-time policy decisions over subscriber access to network resources**

	<p><b>based on volume (usage or time), speed, application type and priority.</b> Its carrier-grade, modular, always-on, stateless architecture enables it to be deployed in a wide range of distributed and scalable environments.”</p> <ul style="list-style-type: none"> <li>• “In addition, the solution’s highly configurable business rules engine enables the application of a wide range of intelligent, <b>real-time controls, including the ability to manage quality of service (QoS) changes, optimize high-bandwidth traffic and enforce usage quotas.</b> Such controls can be used to support an extensive set of use cases for both network optimization and service enablement, including tiered services, customer loyalty programs, video optimization and more.”</li> <li>• “The sophisticated, <b>highly flexible and configurable business rules engine supports the creation of policy rules based on static and dynamic information,</b> enabling rapid launch of innovative diverse service plans. Furthermore, its web-based user interface simplifies creation of sophisticated policy rules governing subscriber data usage and application entitlements.”</li> <li>• “Amdocs Virtual Policy Controller utilizes a standard 3GPP Gx interface, which provides a powerful and flexible <b>real-time metering engine, supporting different traffic flows within an individual user session.</b> It also supports differentiated service tiers requiring multiple scenarios based on time, volume, application or a combination of all three.”  <a href="https://www.amdocs.com/sites/default/files/2019-04/virtual-policy-controller-solution-brief.pdf">https://www.amdocs.com/sites/default/files/2019-04/virtual-policy-controller-solution-brief.pdf</a>).</li> </ul>
<p><b>10[B]</b> a network interface configured to receive a service profile for each of a plurality of devices sharing a network resource and to receive a billing profile for each of said plurality of devices; and</p>	<p><i>See</i> the discussion and evidence recited in limitations 1[B] and 1[C], which are incorporated here by reference.</p> <p>On information and belief, the AT&amp;T network includes a network management server and/or a performance/monitoring server that receives a service profile and a billing profile for each of the customers that are accessing a particular cell site. These servers are responsible for allocating a defined bit rate for each of the customers that are then currently accessing the base station, cell tower, or backhaul network. These servers contain a network interface that allows those devices to receive a service profile for each of a plurality of devices sharing a network resource and to receive a billing profile for each of said plurality of devices. <i>See</i> Claim 1[B] (explaining the circumstances under which customers are subject to “Congestion-based Data Management”, which is relevant to both the service and billing profiles) and Claim 1[C] (explaining that customers under certain AT&amp;T data plans will be</p>

	<p>subject to Congestion-based Data Management only after exceeding a certain monthly data threshold, which is part of the device's billing profile).</p> <p>The specific identity of the network interface(s) that receive the service profile and the billing profile will be provided once discovery is completed on the AT&amp;T internal network architecture and software used to implement the method described relative to Claim 1.</p>
<p><b>10[C]</b> a processor connected to said network interface and configured to generate a prioritization list defining an order of said plurality of devices, based on said billing profiles and on a billing history for each of said plurality of devices;</p>	<p>The server(s) identified in 10[B] include a processor and are configured to generate a prioritization list consistent with the method described in limitation 1[D].</p> <p>The specific identify of the server/processor that generates the prioritization list will be provided once discovery is completed on the AT&amp;T internal network architecture and software used to implement the method described relative to Claim 1.</p>
<p><b>10[D]</b> said processor further configured to repeat:</p>	<p>Implementing AT&amp;T's Broadband Internet Access Services repeats steps 10[E], 10[F], and 10[G] below. <i>See</i> limitation 1[E], which is incorporated here.</p> <p>The specific identify of the server(s)/processor(s) that repeatedly performs the subsequent claimed steps will be provided once discovery is completed on the AT&amp;T internal network architecture and software used to implement the method described relative to Claim 1.</p>
<p><b>10[E]</b> receiving traffic profiles over said network resource for said plurality of devices;</p>	<p><i>See</i> Claim 1[F], which is incorporated here by reference.</p> <p>On information and belief, the AT&amp;T network includes a gateway or aggregating unit that connects to the base stations or cell towers through a backhaul network. The traffic profiles that exist currently on the base station or cell tower or backhaul network are received by the gateway or aggregating unit, which provides that information to the server(s) managing the network resource.</p> <p>The specific identity of the server that receives the traffic profiles will be provided once discovery is completed on the AT&amp;T internal network architecture and software used to implement the method described relative to Claim 1.</p>

<p><b>10[F]</b> managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,</p>	<p><i>See</i> Claim 1[G], which is incorporated here.</p> <p>On information and belief, the AT&amp;T network includes servers that manage the network resource according to the service profile and billing profile when the network resource is fully utilized.</p> <p>The specific identify of the server that performs the management of the network resource will be provided once discovery is completed on the AT&amp;T internal network architecture and software used to implement the method described relative to Claim 1.</p>
<p><b>10[G]</b> selecting at least one of said devices based on said prioritization list and dynamically modifying at least one of said service profile and said billing profile for said selected devices, if said network resource is under-utilized by said traffic profile or if said network resource would be over-utilized by said traffic profiles;</p>	<p><i>See</i> Claim 1[H] and 1[I], which are incorporated here.</p> <p>On information and belief, the AT&amp;T network includes server(s) that select a device from the prioritization list and which modifies the service profile of that selected device when the AT&amp;T network becomes heavily loaded (or congested), and also when the AT&amp;T network reverts from being heavily loaded (or congested) to being lightly loaded.</p> <p>The specific identity of the server the selecting and dynamic modifying of the service profile will be provided once discovery is completed on the AT&amp;T internal network architecture and software used to implement the method described relative to Claim 1.</p>
<p><b>10[H]</b> until said plurality of devices no longer continue to share said network resource; and</p>	<p><i>See</i> Claim 1[J], which is incorporated here.</p> <p>On information and belief, the AT&amp;T network servers identified in the preceding steps (10[E]-[G]) will manage the network resource until the device(s) no longer share the network resource.</p>
<p><b>10[I]</b> said processor further configured, when said plurality of devices are no longer sharing said network resource, to clear said prioritization list.</p>	<p><i>See</i> Claim 1[K], which is incorporated here.</p> <p>On information and belief, the AT&amp;T network servers identified in the preceding steps (10[E]-[G]) will clear the prioritization list when the device(s) no longer shares the network resource.</p>

CLAIM 11	'813 PATENT V. AT&T
<b>11[A].</b> The apparatus of claim 10 wherein said dynamically modifying comprises increasing or reducing an overall bit-rate cap or data volume cap in a service profile for at least one of said devices.	<i>See</i> Claims 2[A] and 10[G], which are incorporated here.

CLAIM 13	'813 PATENT V. AT&T
<b>13[A].</b> The apparatus of claim 10 wherein one of said devices at a first end of said list is a first device to be subject to said dynamically modifying if said network resource would be over-utilized by said traffic profiles.	<i>See Claim 7[A], which is incorporated here.</i>

CLAIM 14	'813 PATENT V. AT&T
<b>14[A].</b> The apparatus of claim 10 wherein one of said devices at a first end of said list is a first device to be subject to said dynamically modifying if said network resource would be under-utilized by said traffic profiles.	<i>See Claim 4[A], which is incorporated here.</i>

CLAIM 15	'813 PATENT V. AT&T
<p><b>15[A].</b> The apparatus of claim 10 wherein said apparatus is incorporated into a policy server that connects to said devices via a public land mobile network infrastructure.</p>	<p>On information and belief, AT&amp;T's network includes a policy server (e.g., PCRF, PCF, Control Plane Function) that includes the dynamic resource allocation apparatus detailed in Claim 10. <i>See</i> 10[A] (detailing policy servers).</p> <p>On information and belief, the policy server connects to cellular devices through a public land mobile network infrastructure, including a backhaul network used to connect the base stations or cell towers to the AT&amp;T core network, a 2G network, a 3G network, a 4G network, and/or a 5G network.</p> <p>The specific identify of the Policy Controller and its associated network connections to which and from which it receives data will be provided once discovery is completed on the AT&amp;T internal network architecture.</p>

CLAIM 17	'813 PATENT V. AT&T
<b>17[A].</b> The apparatus of claim 10 wherein said network interface is configured to connect to a policy server and a billing server that are each connectable to said devices via a public land mobile network infrastructure.	The specific network connections between the policy server and the billing server are currently unknown. Thus, discovery of AT&T's internal network architecture is necessary to assess infringement of this claim.

CLAIM 18	'813 PATENT V. AT&T
<p><b>18[A].</b> A computer-implemented method for dynamic allocation of network resources comprising:</p>	<p>AT&amp;T's Broadband Internet Access Services provides for a computer-implemented method for dynamic allocation of network resources.</p> <p><i>See</i> Claim 1[A], which is incorporated here.</p>
<p><b>18[B]</b> grouping, by a computing system that includes one or more cellular network elements, a plurality of computing devices sharing a cellular network resource;</p>	<p>AT&amp;T's implementation of dynamic allocation of network resources includes performing the step of grouping, by a computing system that includes one or more cellular network elements, a plurality of computing devices sharing a cellular network resource.</p> <p>Implementing AT&amp;T's Broadband Internet Access Services calls for components within AT&amp;T's cellular network (the claimed "computing system") to group computing devices (including mobile phones, tablets, laptops and mobile hotspots) that share a cellular network resource, such as a cell site, base station, cell tower, or backhaul network. For example, AT&amp;T's cellular network identifies the devices connected to a cell site or base station at times and locations when that network resource is congested:</p> <ul style="list-style-type: none"> <li>• "Customers subject to Congestion-based Data Management will experience reduced speeds and increased latency only when they use data at a <i>cell site experiencing network congestion at the same moment</i>. As soon as the congestion at the cell site abates, or if the customer's session migrates to an uncongested cell site, speeds and latency are not affected." (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> <li>• "Congestion-based Data Management. One network management practice we use to manage our wireless network resources may affect customers with most AT&amp;T post-paid and AT&amp;T PREPAID<sup>SM</sup> unlimited mobile data plans ("AT&amp;T Unlimited Data Plans"). During periods of congestion, these customers may experience reduced data speeds and increased latency as <i>compared to other customers using the same cell site</i> ("Congestion-based Data Management"). Depending on the customer's AT&amp;T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&amp;T Unlimited Data Plan (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management</li> </ul>

	<p>practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&amp;T Unlimited Data Plans.”</p> <p><a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</p>
<p><b>18[C]</b> receiving a service profile for each of the plurality of devices sharing the network resource;</p>	<p>AT&amp;T’s implementation of dynamic allocation of network resources includes performing the step of receiving a service profile for each of the plurality of devices sharing the network resource.</p> <p>See limitation 1[B], which is incorporated here.</p> <p>AT&amp;T’s Broadband Internet Access Services receives a service profile (one or more components of information maintained by AT&amp;T regarding a customer’s cellular service/data plan) for each of the plurality of devices sharing the network resource in order to prioritize customer data usage:</p> <ul style="list-style-type: none"> <li>• “Congestion-based Data Management. One network management practice we use to manage our wireless network resources <i>may affect customers with most AT&amp;T post-paid and AT&amp;T PREPAID<sup>SM</sup> unlimited mobile data plans (“AT&amp;T Unlimited Data Plans”).</i> During periods of congestion, these customers may experience reduced data speeds and increased latency as <i>compared to other customers using the same cell site</i> (“Congestion-based Data Management”). <i>Depending on the customer’s AT&amp;T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&amp;T Unlimited Data Plan</i> (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&amp;T Unlimited Data Plans.”</li> <li>• “<i>Customers subject to Congestion-based Data Management</i> will experience reduced speeds and increased latency only when they use data at a <i>cell site experiencing network congestion at the same moment</i>. As soon as the congestion at the cell site abates, or if the customer’s session migrates to an uncongested cell site, speeds and latency are not affected.”</li> </ul> <p><a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</p>

	<ul style="list-style-type: none"> <li>• “<i>For customers on plans subject to a data usage threshold for triggering the foregoing congestion management practice</i>, we will notify them during each billing cycle when their usage reaches 75% of their threshold (so, for example, 16.5GB for plans with a 22GB threshold and 37.5GB for plans with a 50GB threshold) so they can adjust their usage to avoid network management practices that may result in slower data speeds.” (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> </ul>
18[D] receiving a billing profile for each of said plurality of devices;	<p>AT&amp;T’s implementation of dynamic allocation of network resources includes performing the step of receiving a billing profile for each of said plurality of devices.</p> <p>See limitation 1[C], which is incorporated here.</p> <p>AT&amp;T’s Broadband Internet Access Services provides for receiving a billing profile for each of said plurality of devices. The billing profile may include, for example, a rate or charge that each customer pays for accessing the AT&amp;T Services and/or an identification of current network usage for a given billing cycle, such as the amount of premium or high-speed data used or the amount of data used as a high-speed mobile hotspot for a given month. These examples are non-limiting, as other information regarding billing, billing history, usage and usage history may also form part of the billing profile.</p> <p>Implementing AT&amp;T’s Broadband Internet Access Services requires receiving a billing profile (<i>e.g.</i>, one or more components of information maintained by AT&amp;T regarding a billing parameter that regulates rating or charging or both of traffic to and from a customer’s device (<i>e.g.</i>, cellular service/data plan relating to the cost of services provided, including rate schedules, overage charges, and billing history)) for each of said plurality of devices.</p> <ul style="list-style-type: none"> <li>• “Congestion-based Data Management. One network management practice we use to manage our wireless network resources <i>may affect customers with most AT&amp;T post-paid and AT&amp;T PREPAID<sup>SM</sup> unlimited mobile data plans</i> (“<i>AT&amp;T Unlimited Data Plans</i>”). During periods of congestion, these customers may experience reduced data speeds and increased latency as <i>compared to other customers using the same cell site</i> (“Congestion-based Data Management”). <i>Depending on the customer’s AT&amp;T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&amp;T Unlimited Data Plan</i> (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a</li> </ul>

	<p>single monthly flat rate. That is our essential promise with the AT&amp;T Unlimited Data Plans.”  <a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</p> <ul style="list-style-type: none"> <li>• “<i>Customers subject to Congestion-based Data Management</i> will experience reduced speeds and increased latency only when they use data at a <i>cell site experiencing network congestion at the same moment</i>. As soon as the congestion at the cell site abates, or if the customer’s session migrates to an uncongested cell site, speeds and latency are not affected.”  <a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> <li>• “<i>For customers on plans subject to a data usage threshold for triggering the foregoing congestion management practice</i>, we will notify them during each billing cycle when their usage reaches 75% of their threshold (so, for example, 16.5GB for plans with a 22GB threshold and 37.5GB for plans with a 50GB threshold) so they can adjust their usage to avoid network management practices that may result in slower data speeds.”  <a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> </ul> <p>AT&amp;T advertises that under certain wireless plans, “AT&amp;T may temporarily slow data speeds if the network is busy.” The service profile for a particular user will impact whether their broadband access speed is reduced (sometimes after a certain data threshold is reached):</p>
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The screenshot displays three AT&T wireless plans side-by-side. The first plan, 'AT&T UNLIMITED ELITE® PLAN', is priced at \$50/mo. per line and includes HBO Max™ and 5G access. The second plan, 'AT&T UNLIMITED EXTRA® PLAN', is priced at \$40/mo. per line and includes 5G access. The third plan, 'AT&T UNLIMITED STARTER® PLAN', is priced at \$35/mo. per line and includes 5G access. All plans offer unlimited talk, text, and data, with varying hotspots and streaming options. A 'Get started' button and a link to 'Learn more about Unlimited Your Way™' are at the bottom.

Plan Name	Price	Key Features
AT&T UNLIMITED ELITE® PLAN	\$50/mo. per line	HBO Max™ + 5G included, 40GB Hotspot data, 4K UHD streaming, Signature Program members save up to \$10/mo.
AT&T UNLIMITED EXTRA® PLAN	\$40/mo. per line	5G included, 15GB Hotspot data, Standard-definition streaming, Stadia Pro—6 months of streaming gaming on us.
AT&T UNLIMITED STARTER® PLAN	\$35/mo. per line	5G included, Unlimited texting from U.S. to 200+ countries, Standard-definition streaming, Stadia Pro—6 months of streaming gaming on us.

<https://www.att.com/plans/wireless/>

AT&T states that it may impose “maximum speed limit[s]” under certain wireless plans:

- “*Mobile Service.* Some AT&T mass market mobile broadband internet access services limit access to certain network technologies or ***impose a maximum speed limit, which is outlined in the applicable data service plan***, subject to the factors and the network management practices that can affect network performance, discussed above. Other plans provide access to all available network technologies and provide customers with the highest speed available from the network at a particular location and at a given point of time based on the capabilities of the customer's device, subject to the factors and network management practices discussed above. In addition,

	<p>some service plans include maximum data transmission rates for video and/or other data traffic. For example, the now grandfathered AT&amp;T Unlimited Choice plan originally limited data transmission rates to 1.5 Mbps for video and 3.0 Mbps for other data traffic. <i>Similarly, some AT&amp;T plans provide customers a monthly per line allotment of mobile hotspot/tethering usage after which the data transmission rate for tethered data for that device will be limited to a significantly slower speed (e.g., 128 Kbps) for the remainder of the bill cycle, as set forth in the terms of the plan.</i>” (<a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</p> <ul style="list-style-type: none"> <li>• “Mobile Services. <i>Service performance may be affected by</i> your proximity to a cell site, the capacity of the cell site, the technology at the cell site, the number of other users connected to the same cell site and the services they are using, the surrounding terrain, use inside a building or a moving vehicle, radio frequency interference, <i>your mobile data plan</i>, the capabilities of your device, applicable network management practices as discussed on this page, and the applications you use. In addition, AT&amp;T has designed its wireless services to provide our customers with a high-quality voice experience during simultaneous voice and data sessions, which may affect data performance, including but not limited to a temporary reduction in speed to minimize the likelihood of dropped calls.” (<a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</li> </ul> <p>AT&amp;T explains to its customers that with respect to AT&amp;T’s “unlimited” plans, “unlimited does not mean that wireless data will be transmitted at any particular speed.”</p> <ul style="list-style-type: none"> <li>• “If you are subscribed to an AT&amp;T unlimited data plan, you agree that “unlimited” means you pay a single monthly flat rate for wireless Data Service regardless of how much data you use. <i>You further agree that “unlimited” does not mean that wireless data will be transmitted at any particular speed</i> or that you can use AT&amp;T’s wireless Data Service in any way that you choose or for any Prohibited Network Uses. If you use your unlimited data plan in any manner that is prohibited, AT&amp;T can limit, restrict, suspend or terminate your Data Service. We may also migrate you from the unlimited data plan to a tiered data plan and charge you the appropriate monthly fees. We will provide you with notice of this change at least one billing period in advance either by a bill message, email, text message, or other appropriate means. Except for FirstNet individual users, AT&amp;T may also reduce your data throughput speeds at any time based on the terms of your data plan, which may include times when your usage exceeds an applicable,</li> </ul>
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	<p>identified data usage threshold during any billing period. <b><i>Reduced data throughput speeds mean you may experience reduced data speeds and increased latency, which may cause websites to load more slowly and affect the performance of data-heavy activities such as video streaming.</i></b> Reduced data throughput speeds apply when using Data Services at times and in areas experiencing network congestion compared to other customers using the same cell site. Standard speeds will resume once the cell site is no longer congested or when your data session moves to an uncongested cell site, and speeds will no longer be reduced during periods of network congestion at the start of your next billing period, <b><i>unless your usage again exceeds an applicable, identified data usage threshold for that next billing period.</i></b> There are no mobile network-related speed reductions if you use Wi-Fi, and Wi-Fi data usage does not count against a monthly data usage threshold for wireless Data service. For more information, go to att.com/broadbandinfo and att.com/datainfo.”</p> <p>(<a href="https://www.att.com/legal/terms.consumerServiceAgreement.html">https://www.att.com/legal/terms.consumerServiceAgreement.html</a>)</p>
<p><b>18[E]</b> generating a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing history for each of said plurality of devices;</p>	<p>AT&amp;T’s implementation of dynamic allocation of network resources includes performing the step of generating a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing history for each of said plurality of devices.</p> <p>See limitation 1[D], which is incorporated by reference here.</p> <p>AT&amp;T’s Broadband Internet Access Services generate a prioritization list that is in part based on the billing profiles and a billing history (e.g., prioritization will consider the specific plan, features, and/or previously paid data usage) for each of the devices.</p> <p>The prioritization list defines an order for the plurality of devices accessing a shared network resource (e.g., a cell tower or base station or backhaul link), based on the billing profiles and billing history for each of the plurality of devices. For example, on information and belief, AT&amp;T generates a prioritization list to determine which, if any, device will see a decrease in data speed based on, in part, the plan associated with the device (which is part of the “billing profile”) and the amount and/or type of data transmitted under that plan for a particular billing period or whether a user has failed to pay amounts owed AT&amp;T (which forms part of the billing history). On information and belief, whether a user’s device will experience decreased data speeds depends on, in part, the billing profile (e.g., specific plan and the data usage for a particular billing period).</p>

Implementing AT&T's Broadband Internet Access Services requires generating a prioritization list that is in part based on the billing profiles and a billing history (*e.g.*, prioritization will consider the specific plan, features, and/or previously paid data usage) for each of the devices.

See 1[C]. AT&T prioritizes certain user's traffic:

- "Congestion-based Data Management. One network management practice we use to manage our wireless network resources *may affect customers with most AT&T post-paid and AT&T PREPAID<sup>SM</sup> unlimited mobile data plans* ("AT&T Unlimited Data Plans"). During periods of congestion, these customers may experience reduced data speeds and increased latency as compared to other customers using the same cell site ("Congestion-based Data Management"). *Depending on the customer's AT&T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan* (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans." (<https://about.att.com/sites/broadband/network>)

This prioritization is based on the billing profile (*e.g.*, data plan) and billing history (*e.g.*, high speed usage during your billing cycle) associated with the device:

- "*For customers on plans subject to a data usage threshold for triggering the foregoing congestion management practice*, we will notify them during each billing cycle when their usage reaches 75% of their threshold (so, for example, 16.5GB for plans with a 22GB threshold and 37.5GB for plans with a 50GB threshold) so they can adjust their usage to avoid network management practices that may result in slower data speeds." (<https://about.att.com/sites/broadband/network>)
- "Congestion-based Data Management. One network management practice we use to manage our wireless network resources *may affect customers with most AT&T post-paid and AT&T PREPAID<sup>SM</sup> unlimited mobile data plans* ("AT&T Unlimited Data Plans"). During periods of congestion, these customers may experience reduced data speeds and increased latency as compared to other customers using the same cell site ("Congestion-based Data Management").

*Depending on the customer's AT&T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans."* (<https://about.att.com/sites/broadband/network>)

The screenshot displays three AT&T Unlimited Data Plans side-by-side. Each plan includes a price per line, a list of features, and a 'Get started' button at the bottom.

Plan Name	Price /mo. per line (when you get 4 lines)	Key Features
AT&T UNLIMITED ELITE® PLAN	\$50	<ul style="list-style-type: none"> <li>Unlimited talk, text, &amp; high-speed data that can't slow down based on how much you use</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® advanced security (including spam &amp; fraud call blocking, identity monitoring, safe browsing, and more)</li> <li>40GB Hotspot data per line per month</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>4K UHD streaming available</li> <li>HBO Max™ included</li> <li>Stadia Pro—6 months of streaming gaming on us</li> <li>Signature Program members save up to \$10/mo. per line through your work or organization</li> </ul>
AT&T UNLIMITED EXTRA® PLAN	\$40	<ul style="list-style-type: none"> <li>Unlimited talk, text, data + 50GB of Premium Data (After 50GB, AT&amp;T may temporarily slow data speeds if the network is busy)</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® advanced security (including spam &amp; fraud call blocking, identity monitoring, safe browsing, and more)</li> <li>15GB Hotspot data per line per month</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>SD Standard-definition streaming</li> <li>Stadia Pro—6 months of streaming gaming on us</li> </ul>
AT&T UNLIMITED STARTER® PLAN	\$35	<ul style="list-style-type: none"> <li>Unlimited talk, text &amp; data (AT&amp;T may temporarily slow data speeds if the network is busy)</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® security (including spam &amp; fraud call blocking, and more)</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>SD Standard-definition streaming</li> <li>Stadia Pro—6 months of streaming gaming on us</li> </ul>

At the bottom of the screenshot, there is a 'Get started' button and a link: [Learn more about Unlimited Your Way™](#).

<https://www.att.com/plans/wireless/>

<p><b>18[F]</b> repeating, by the computing system:</p>	<p>Implementing AT&amp;T's Broadband Internet Access Services repeats, by the computing system, steps 18[G]-18[J] below.</p> <p>See limitation 1[E], which is incorporated here.</p>
<p><b>18[G]</b> determining and receiving traffic profiles indicating attributes of current traffic activity over said network resource by said plurality of devices;</p>	<p>AT&amp;T's implementation of dynamic allocation of network resources includes performing the step of determining and receiving traffic profiles indicating attributes of current traffic activity over said network resource by said plurality of devices.</p> <p>See limitation 1[F], which is incorporated here.</p> <p>Implementing AT&amp;T's Broadband Internet Access Services determines and receives traffic profiles indicating attributes of current traffic activity over said network resource by said plurality of devices.</p> <ul style="list-style-type: none"> <li>• “<i>Customers subject to Congestion-based Data Management</i> will experience reduced speeds and increased latency only when they use data at a <i>cell site experiencing network congestion at the same moment</i>. As soon as the congestion at the cell site abates, or if the customer's session migrates to an uncongested cell site, speeds and latency are not affected.” (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> <li>• “Mobile Services. <i>Service performance may be affected by</i> your proximity to a cell site, the capacity of the cell site, the technology at the cell site, <i>the number of other users connected to the same cell site and the services they are using</i>, the surrounding terrain, use inside a building or a moving vehicle, radio frequency interference, <i>your mobile data plan</i>, the capabilities of your device, applicable network management practices as discussed on this page, and the applications you use. In addition, AT&amp;T has designed its wireless services to provide our customers with a high-quality voice experience during simultaneous voice and data sessions, which may affect data performance, including but not limited to a temporary reduction in speed to minimize the likelihood of dropped calls.” (<a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</li> </ul>

	<p>Prioritization therefore necessarily requires AT&amp;T's cellular network to first determine whether there is any traffic over the network resource, such as one or more cell phones transmitting data through a cell site or base station or other shared network resource between the mobile device and core network.</p>
<p><b>18[H]</b> managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,</p>	<p>AT&amp;T's implementation of dynamic allocation of network resources includes performing the step of managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles.</p> <p>See limitation 1[G], which is incorporated here.</p>
<p><b>18[I]</b> selecting at least one of said devices based on said prioritization list; and</p>	<p>AT&amp;T's implementation of dynamic allocation of network resources includes performing the step of selecting at least one of said devices based on said prioritization list.</p> <p>See limitation 1[H], which is incorporated here.</p> <p>Implementing AT&amp;T's Broadband Internet Access Services requires selecting at least one of the devices for prioritization.</p>
<p><b>18[J]</b> dynamically modifying said service profile for the selected devices, if said network resource is under-utilized by said traffic profiles or if said network resource would be over-utilized by said traffic profiles, wherein the dynamic modification includes automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to</p>	<p>AT&amp;T's implementation of dynamic allocation of network resources includes performing the step of dynamically modifying said service profile for the selected devices, if said network resource is under-utilized by said traffic profiles or if said network resource would be over-utilized by said traffic profiles, wherein the dynamic modification includes automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to contention for the shared network resource.</p> <p>See the discussion and evidence referenced in limitation 1[I], which is incorporated here.</p> <p>Implementing AT&amp;T's Broadband Internet Access Services requires dynamically modifying at least the service profile(s) by adjusting the data speeds when the resource is over utilized by the customer's data requests.</p> <ul style="list-style-type: none"> <li>• In addition, <i>this network management practice adjusts dynamically to address the amount of congestion</i>, which can start and stop over a very short time period (often measured in fractions of a second), further minimizing any customer impact. Because the amount of congestion at a cell site can vary significantly, the performance impact for affected AT&amp;T Unlimited Data Plan</li> </ul>

<p>contention for the shared network resource;</p>	<p>customers may also vary significantly, but such impact will last only as long as the site is congested. (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</p> <p>AT&amp;T explains that it “may temporarily slow your speed at any time if our network is busy.” This intentional slowing is a reduction in the maximum guaranteed bit rate for a particular device.</p> <ul style="list-style-type: none"> <li>• “If a lot of devices are using mobile data at once, it can put a strain in our network. This is called network congestion, and we may have to slow your data speed to keep everyone connected. On an unlimited plan? <i>We may temporarily slow your speed at any time if our network is busy.</i> We may also slow it after you use more than 50GB or 22GB of data in a single bill period.” (<a href="https://www.att.com/help/wireless/data-usage/">https://www.att.com/help/wireless/data-usage/</a>)</li> </ul>
<p><b>18[K]</b> until said plurality of devices no longer continue to share said network resource; and</p>	<p>AT&amp;T’s implementation of dynamic allocation of network resources includes repeating the steps 18[G]-18[J] until said plurality of devices no longer continue to share said network resource.</p> <p>See limitations 1[J] and 1[I], which are incorporated here.</p>
<p><b>18[L]</b> when said plurality of devices are no longer sharing said network resource, clearing said prioritization list.</p>	<p>AT&amp;T’s implementation of dynamic allocation of network resources includes performing the step of, when said plurality of devices are no longer sharing said network resource, clearing said prioritization list.</p> <p>See limitation 1[K], which is incorporated here.</p>

CLAIM 19	'813 PATENT V. AT&T
<p><b>19[A].</b> The method of claim 18, wherein the network resource is a cellular base station.</p>	<p>AT&amp;T identifies a “cell site,” which includes a base station, as a shared network resource.</p> <p>AT&amp;T operates and sells access to its cellular communication network that provides cellular and data services to its customers via cellular base stations (also referred to at times as cell towers) located throughout the United States, and thereby directly infringes this method claim. These base stations communicate with customers’ mobile cellular devices (including mobile phones, tablets, laptops and mobile hotspots) in accordance with 3G, 4G, 4G LTE and 5G mobile network standards. <i>See e.g.</i> <a href="https://www.att.com/5g/coverage-map/">https://www.att.com/5g/coverage-map/</a> (last visited January 18, 2022); <a href="https://www.att.com/offers/network/">https://www.att.com/offers/network/</a> (last visited January 18, 2022); <a href="https://www.att.com/5g/consumer/">https://www.att.com/5g/consumer/</a> (last visited January 18, 2022).</p> <p>AT&amp;T identifies a “cell site” as a shared network resource. AT&amp;T explains that cell sites are shared by multiple devices:</p> <ul style="list-style-type: none"> <li>• “Customers subject to Congestion-based Data Management will experience reduced speeds and increased latency only when they use data at a <i>cell site experiencing network congestion at the same moment</i>. As soon as the congestion at the cell site abates, or if the customer’s session migrates to an uncongested cell site, speeds and latency are not affected.” (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> </ul>

CLAIM 20	'813 PATENT V. AT&T
<b>20[A].</b> The method of claim 18, wherein the network resource is a backhaul link.	The base stations or cell towers connect to the AT&T core network through a backhaul link. Like the base stations, the backhaul link is a network resource that is shared by the cellular devices that are accessing the AT&T network. Like the base station or cell tower, the capability of the backhaul network to carry data traffic has a physical limit. On information and believe, AT&T monitors the backhaul link and will dynamically modify the load on the backhaul link in situations where the traffic demand exceeds capacity.

CLAIM 21	'813 PATENT V. AT&T
<p><b>21[A].</b> The method of claim 18, wherein the traffic profiles over the network resource indicate: data rates, data volumes, types of content, radio access type, congestion information, and device type.</p>	<p>Implementing AT&amp;T's Broadband Internet Access Services considers whether the traffic profiles over the network resource indicate: data rates, data volumes, types of content, radio access type, congestion information, and device type.</p> <ul style="list-style-type: none"> <li>• <i>“Customers subject to Congestion-based Data Management will experience reduced speeds and increased latency only when they use data at a cell site experiencing network congestion at the same moment. As soon as the congestion at the cell site abates, or if the customer's session migrates to an uncongested cell site, speeds and latency are not affected.”</i> (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> <li>• <i>“Mobile Services. Service performance may be affected by your proximity to a cell site, the capacity of the cell site, the technology at the cell site, the number of other users connected to the same cell site and the services they are using, the surrounding terrain, use inside a building or a moving vehicle, radio frequency interference, your mobile data plan, the capabilities of your device, applicable network management practices as discussed on this page, and the applications you use. In addition, AT&amp;T has designed its wireless services to provide our customers with a high-quality voice experience during simultaneous voice and data sessions, which may affect data performance, including but not limited to a temporary reduction in speed to minimize the likelihood of dropped calls.”</i> (<a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</li> </ul>

CLAIM 23	'813 PATENT V. AT&T
<p><b>23[A].</b> The method of claim 18, wherein the dynamic modification further includes modifying a restriction on one or more content types.</p>	<p>Implementing AT&amp;T's Broadband Internet Access Services allows for the dynamic modification further to modify a restriction on one or more content types. For example, the prioritization may reduce the typical speed of video streams (which stream video at 480p or 1080p depending on the AT&amp;T plan):</p> <ul style="list-style-type: none"> <li>• “Stream Saver. Another reasonable network management practice we use to more efficiently manage our wireless network resources is Stream Saver, which is <i>a feature we offer on some of our wireless plans that include data. Stream Saver allows customers to watch more video over our wireless network while using less data by streaming content recognized as video content at Standard Definition quality, similar to DVD (about 480p, max 1.5 mbps)</i>. In instances where a content provider uses the same server name identification (SNI) or URL to deliver both streaming video and downloadable video, Stream Saver may treat the downloadable video and thereby affect the speed of the video download. Stream Saver applies only to recognized video content delivered over AT&amp;T's wireless network. If two or more tethered devices are watching video from the same source at the same time, we may identify it as a single video and slow the speeds collectively to a max of 1.5 Mbps, which may impair your ability to watch video on these tethered devices. You can pause video on all but one of the tethered devices, watch video from different sources, or turn off Stream Saver to resolve this issue. Once activated by AT&amp;T on a customer's account for plans that include Stream Saver, the customer can turn it off and back on at any time via the customer's online account or by calling AT&amp;T.” (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> <li>• “Stream Saver allows you to watch more video on your wireless devices while using less data by streaming content that it recognizes as video at Standard Definition quality, similar to DVD, (about 480p), so you can enjoy more of what you love on your smartphone or tablet. You will have control over which lines on your account use Stream Saver and can turn it off or on at any time once AT&amp;T activates it.” (<a href="https://www.att.com/offers/stream saver/">https://www.att.com/offers/stream saver/</a>)</li> <li>• “<i>Mobile Service.</i> Some AT&amp;T mass market mobile broadband internet access services limit access to certain network technologies or impose a maximum speed limit, which is outlined in the applicable data service plan, subject to the factors and the network management practices that can affect network performance, discussed above. Other plans provide access to all available network technologies and provide customers with the highest speed available from the network</li> </ul>

	<p>at a particular location and at a given point of time based on the capabilities of the customer's device, subject to the factors and network management practices discussed above. <b><i>In addition, some service plans include maximum data transmission rates for video and/or other data traffic. For example, the now grandfathered AT&amp;T Unlimited Choice plan originally limited data transmission rates to 1.5 Mbps for video and 3.0 Mbps for other data traffic.</i></b> Similarly, some AT&amp;T plans provide customers a monthly per line allotment of mobile hotspot/tethering usage after which the data transmission rate for tethered data for that device will be limited to a significantly slower speed (e.g., 128 Kbps) for the remainder of the bill cycle, as set forth in the terms of the plan.” (<a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</p> <p>Similarly, under certain AT&amp;T plans, AT&amp;T will automatically cap the data rate for streaming video. For example, under the Unlimited Extra Plan, “For content we can identify as video, wireless streaming speed will be slowed to Standard Definition quality. Video speed is capped at Standard Definition, regardless of the network the device is on.” (<a href="https://www.att.com/plans/wireless/">https://www.att.com/plans/wireless/</a>)</p>
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CLAIM 25	'813 PATENT V. AT&T
<p><b>25[A].</b> The method of claim 18, wherein the receiving the service profile for each of the plurality of devices includes one or more of: accessing a memory of the computing system or receiving data via a network link.</p>	<p>AT&amp;T's network services implementation of dynamic resource allocations includes receiving the service profile for each of the plurality of devices via one or more of: accessing a memory of the computing system or receiving data via a network link.</p> <p><i>See</i> 1[B], 1[C] (detailing SPR and UDR).</p> <div data-bbox="617 526 1860 794" style="border: 1px solid black; padding: 10px; margin: 10px 0;"> <p><b>Introduction</b></p> <p>The UDC concept (3GPP TS 22.101 [3]) supports a layered architecture, separating the data from the application logic in the 3GPP system, so that user data is stored in a logically unique repository allowing access from core and service layer entities, named Application Front Ends.</p> <p>Network elements and functionalities should be designed to access user data remotely and without storing them permanently locally, i.e. the Front Ends shall work in a subscriber dateless configuration.</p> </div> <p>3GPP TS 23.335 version 16.0.0 Release 16 at 5 (2020-07).</p>

## 4 User Data Convergence architecture

### 4.1 UDC System architecture

Figure 4.1-1 presents the reference UDC architecture. UDC is the logical representation of the layered architecture that separates the user data from the application logic, so that user data is stored in a logically unique repository allowing access from entities handling an application logic, hereby named Application Front Ends.

In the architecture, the User Data Repository (UDR) is a functional entity that acts as a single logical repository of user data and is unique from Application Front End's perspective. Entities which do not store user data and that need to access user data stored in the UDR are collectively known as application front ends.

NOTE: Depending on the different network deployment, there may be more than one UDC in an operator's network.

Application Front Ends connect to the UDR through the reference point named Ud to access user data.

Reference points towards network elements are marked in discontinuous lines in Figure 4.1-1, and are just shown for information purposes only. Details of the roles of these functional entities are described in sections 4.2.1, 4.2.2, 4.2.3 and 4.2. 4.

3GPP TS 23.335 version 16.0.0 Release 16 at 8 (2020-07); *see also id.* at 9 (illustrating and describing UDC reference architecture).

#### 4.2.3 User Data Repository

The User Data Repository (UDR) is a functional entity that acts as a single logical repository that stores converged user data. The user-related data that traditionally has been stored into the HSS /HLR/AuC, Application Servers, etc., is now stored in the UDR according to a UDC information model. UDR facilitates the share and the provisioning of user-related data throughout services of 3GPP system.

3GPP TS 23.335 version 16.0.0 Release 16 at 11 (2020-07).

The UDR functional entity may be distributed over different locations or be centralized; it may support replication mechanisms, back up functions and geographical redundancy to secure the storage of data. These functions are out of the scope of the present specification. They do not impact the functional content of the reference point Ud.

The UDR shall be able to store the following types of data:

- Permanent subscriber data: this is subscription data and relates to the necessary information the system ought to know to perform the service. User identities (e.g. MSISDN, IMSI, IMPU, IMPI), service data (e.g. service profile in IMS) and authentication data are examples of the subscription data. This kind of user data has a lifetime as long as the user is permitted to use the service and may be modified by administration means.
- Temporary subscriber data: this is data which may be changed as a result of normal operation of the system or traffic conditions (e.g. transparent data stored by Application Servers for service execution, SGSN number, user status, etc.).

3GPP TS 23.335 version 16.0.0 Release 16 at 11 (2020-07).

CLAIM 26	'813 PATENT V. AT&T
<b>26[A].</b> The method of claim 18, wherein the dynamic modification is performed only if said network resource would be over-utilized by said traffic profiles.	<i>See</i> limitations 1[I] and 18[J], which are incorporated here.

CLAIM 27	'813 PATENT V. AT&T
<b>27[A]</b> . A method for dynamic allocation of network resources comprising:	<i>See</i> limitations 1[A] and 18[A], which are incorporated here.
<b>27[B]</b> grouping, by a computing system of a cellular network, a plurality of computing devices sharing a cellular network resource;	<i>See</i> limitation 18[B], which is incorporated here.
<b>27[C]</b> receiving, by the computing system, a service profile for each of the plurality of devices sharing the network resource;	<i>See</i> limitations 1[B] and 18[C], which are incorporated here.
<b>27[D]</b> receiving, by the computing system, a billing profile for each of said plurality of devices;	<i>See</i> limitations 1[C] and 18[D], which are incorporated here.
<b>27[E]</b> generating, by the computing system, a prioritization list defining an order of said plurality of devices, within the group based on said billing	<i>See</i> limitations 1[D] and 18[E], which are incorporated here.

profiles and on a billing history for each of said plurality of devices;	
<b>27[F]</b> repeating, by the computing system, until said plurality of devices no longer continue to share said network resource:	Implementing AT&T's Broadband Internet Access Services repeats, by the computing system, steps 27[G]-27[K] below. <i>See</i> limitations 1[E], 1[J], 18[F], and 18[J], which are incorporated here.
<b>27[G]</b> receiving traffic profiles over said network resource for said plurality of devices, wherein the traffic profiles over said network resource indicate attributes of data communicated by corresponding ones of the devices using the network resource;	<i>See</i> limitations 1[F] and 18[G] (describing how AT&T's Broadband Internet Access Services receives traffic profiles over the network resource for the plurality of devices) and 21[A] (explaining how the traffic profiles indicate attributes of data communicated by the corresponding devices, such as data rates, data volumes, types of content, radio access type, congestion information, and device type), all incorporated here.
<b>27[H]</b> managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,	<i>See</i> limitations 1[G] and 18[H], which are incorporated here.
<b>27[I]</b> selecting at least one of said devices based on said prioritization list; and	<i>See</i> limitations 1[H] and 18[I], which are incorporated here.

<p><b>27[J]</b> dynamically modifying said service profile for said selected devices, if said network resource is under-utilized by said traffic profile or if said network resource would be over-utilized by said traffic profiles, wherein the dynamically modifying includes modifying a restriction on communications for the at least one of said plurality of devices;</p>	<p>See limitations 1[I] and 18[J], which are incorporated here.</p>
<p><b>27[K]</b> managing said network resource to according to at least one dynamically modified service profile; and</p>	<p>AT&amp;T's implementation of dynamic allocation of network resources includes performing the step of managing said network resource according to at least one dynamically modified service profile.</p> <p>See limitations 1[G] and 18[H], which are incorporated here. Additional examples and discussion relevant to this limitation are found in limitations 1[J] and 18[K].</p> <p>Implementing AT&amp;T's Broadband Internet Access Services manages the shared network resources according to at least one dynamically modified service profile. For example, the shared network resource will allocate different capacity and/or data bit rates to customer devices depending on the prioritization of a particular customer during periods of congestion:</p> <ul style="list-style-type: none"> <li>• “Congestion-based Data Management. One network management practice we use to manage our wireless network resources <i>may affect customers with most AT&amp;T post-paid and AT&amp;T PREPAID<sup>SM</sup> unlimited mobile data plans (“AT&amp;T Unlimited Data Plans”).</i> During periods of congestion, these customers may experience reduced data speeds and increased latency as <i>compared to other customers using the same cell site</i> (“Congestion-based Data Management”). <i>Depending on the customer's AT&amp;T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&amp;T Unlimited Data Plan</i> (for example, 22GB</li> </ul>

	<p>or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&amp;T Unlimited Data Plans.”  <a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</p> <ul style="list-style-type: none"> <li>• “Mobile Services. <i>Service performance may be affected by</i> your proximity to a cell site, the capacity of the cell site, the technology at the cell site, the number of other users connected to the same cell site and the services they are using, the surrounding terrain, use inside a building or a moving vehicle, radio frequency interference, <i>your mobile data plan</i>, the capabilities of your device, applicable network management practices as discussed on this page, and the applications you use. In addition, AT&amp;T has designed its wireless services to provide our customers with a high-quality voice experience during simultaneous voice and data sessions, which may affect data performance, including but not limited to a temporary reduction in speed to minimize the likelihood of dropped calls.”  <a href="https://about.att.com/sites/broadband/performance">https://about.att.com/sites/broadband/performance</a>)</li> </ul>
<p><b>27[L]</b> when said plurality of devices are no longer sharing said network resource, the computing system clearing said prioritization list.</p>	<p>See limitations 1[K] and 18[L], which are incorporated here.</p>

CLAIM 28	'813 PATENT V. AT&T
<b>28[A].</b> The method of claim 27, wherein the network resource is a cellular base station or a back-haul link.	<i>See</i> limitations 19[A] and 20[A], which are incorporated here.

CLAIM 29	'813 PATENT V. AT&T
<b>29[A].</b> The method of claim 28, wherein the traffic profiles over the network resource indicate: wherein the traffic profiles over the network resource indicate: data rates, data volumes, types of content, radio access type, congestion information, and device type.	<i>See limitation 21[A], incorporated here.</i>

CLAIM 31	'813 PATENT V. AT&T
<b>31[A].</b> The method of claim 27, wherein the dynamic modification includes modifying a restriction on video content.	<i>See</i> limitation 23[A], incorporated here.

CLAIM 32	'813 PATENT V. AT&T
<b>32[A].</b> The method of claim 27, wherein the receiving the service profile for each of the plurality of devices includes one or more of: accessing a memory of the computing system or receiving data via a network link.	<i>See limitation 25[A], incorporated here.</i>

CLAIM 33	'813 PATENT V. AT&T
<b>33[A].</b> The method of claim 27, wherein the dynamic modification is performed if said network resource would be over-utilized by said traffic profiles and not if said network resource would be under-utilized by said traffic profiles.	<i>See</i> limitations 1[I] and 18[J] (describing dynamic modification in the event of network congestion), which are incorporated here.

CLAIM 34	'813 PATENT V. AT&T
<b>34[A]</b> . A method for dynamic allocation of network resources comprising:	<i>See</i> limitation 27[A], incorporated here.
<b>34[B]</b> grouping, by a computing system of a cellular network, a plurality of computing devices sharing a cellular network resource, wherein the cellular network resource is a base station or a back-haul link;	<i>See</i> limitations 27[B] and 28[A], incorporated here.
<b>34[C]</b> receiving, by the computing system, a service profile for each of the plurality of devices sharing the network resource;	<i>See</i> limitation 27[C], incorporated here.
<b>34[D]</b> receiving, by the computing system, a billing profile for each of said plurality of devices;	<i>See</i> limitation 27[D], incorporated here.
<b>34[E]</b> generating, by the computing system, a prioritization list defining	<i>See</i> limitation 27[E], incorporated here.

an order of said plurality of devices, based on said billing profiles and on a billing history for each of said plurality of devices;	
<b>34[F]</b> repeating, by the computing system:	<i>See</i> limitations 1[E] and 18[F], which are incorporated here. Implementing AT&T's Broadband Internet Access Services repeats, by the computing system, steps 34[G]-34[L] below.
<b>34[G]</b> receiving traffic profiles that indicate attributes of current traffic activity over said network resource for each of said plurality of devices;	<i>See</i> limitations 1[F], 18[G], and 27[G], which are incorporated here.
<b>34[H]</b> managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles, wherein the traffic profiles indicate data rates, data volumes, and types of content for ones of said plurality of devices; and,	<i>See</i> limitations 1[H] and 18[H] (describing managing a network resource according to service and billing profiles if the resource is fully utilized) and limitation 21[A] (describing that the traffic profiles indicate data rates, data volumes, and types of content, among other parameters), which are incorporated here.
<b>34[I]</b> selecting at least one of said devices based on said prioritization list and	<i>See</i> limitations 1[H] and 18[I], which are incorporated here.

<p><b>34[J]</b> dynamically modifying said service profile for said at least one selected devices, if said network resource is under-utilized by said traffic profiles or if said network resource would be over-utilized by said traffic profiles wherein the dynamic modification includes:</p>	<p><i>See</i> limitations 1[I] and 18[J], which are incorporated here.</p>
<p><b>34[K]</b> automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to contention for the shared network resource; and</p>	<p><i>See</i> limitations 1[I] and 18[J], which are incorporated here.</p>
<p><b>34[L]</b> adjusting a restriction on one or more multimedia content types in response to contention for the shared network resource;</p>	<p><i>See</i> limitation 23[A] (describing that AT&amp;T's Broadband Internet Access Services reduce the typical speed of video streams during periods of congestion, which adjusts the restriction on the default speeds, which vary by plan, for video streaming).</p>
<p><b>34[M]</b> until said plurality of devices no longer continue to share said network resource; and</p>	<p>Implementing AT&amp;T's Broadband Internet Access Services repeats steps 34[G]-35[L] until said plurality of devices no longer continue to share said network resource.</p> <p><i>See</i> limitations 1[J] and 18[K], which are incorporated here.</p>

<p><b>34[N]</b> when said plurality of devices are no longer sharing said network resource, the computing system clearing said prioritization list.</p>	<p><i>See</i> limitations 1[K] and 18[L], which are incorporated here.</p>
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CLAIM 35	'813 PATENT V. AT&T
<b>35[A].</b> The method of claim 34, wherein the receiving the service profile for each of the plurality of devices includes one or more of: accessing a memory of the computing system or receiving data via a network link.	<i>See</i> limitation 25[A] (describing a similar limitation).

CLAIM 36	'813 PATENT V. AT&T
<b>36[A].</b> The method of claim 34, wherein the dynamic modification is performed if said network resource would be over-utilized by said traffic profiles and not if said network resource would be under-utilized by said traffic profiles.	<i>See</i> limitation 33[A], which is incorporated here.

CLAIM 37	'813 PATENT V. AT&T
<b>37[A]</b> . An apparatus for dynamic allocation of network resources in a cellular network comprising:	<i>See</i> limitation 10[A], which is incorporated here.
<b>37[B]</b> a network interface configured to receive a service profile for each of a plurality of devices sharing a hardware network resource and to receive a billing profile for each of said plurality of devices; and	<i>See</i> limitation 10[B], which is incorporated here.
<b>37[C]</b> a processor connected to said network interface and configured to group the plurality of devices sharing the cellular network resources and generate a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing history for each of said plurality of devices;	<p>The server(s) identified in 10[B] include processors and are configured to generate a prioritization list consistent with the methods described in limitations 1[D] and 18[B], incorporated herein.</p> <p>The specific identity of the server/processor that generates the prioritization list will be provided once discovery is completed on the AT&amp;T internal network architecture and software used to implement the method described relative to Claims 1 and 18.</p> <p>Implementing AT&amp;T's Broadband Internet Access Services calls for components within AT&amp;T's cellular network (the claimed "computing system") to group computing devices (including mobile phones, tablets, laptops and mobile hotspots) that share a cellular network resource, such as a cell site, base station, cell tower, or backhaul network. For example, AT&amp;T's cellular network identifies the devices connected to a cell site or base station at times and locations when that network resource is congested:</p>

- “Customers subject to Congestion-based Data Management will experience reduced speeds and increased latency only when they use data at a *cell site experiencing network congestion at the same moment*. As soon as the congestion at the cell site abates, or if the customer’s session migrates to an uncongested cell site, speeds and latency are not affected.” (<https://about.att.com/sites/broadband/network>)
- “Congestion-based Data Management. One network management practice we use to manage our wireless network resources may affect customers with most AT&T post-paid and AT&T PREPAIDSM unlimited mobile data plans (“AT&T Unlimited Data Plans”). During periods of congestion, these customers may experience reduced data speeds and increased latency *as compared to other customers using the same cell site* (“Congestion-based Data Management”). Depending on the customer’s AT&T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans.” (<https://about.att.com/sites/broadband/network>)

AT&T’s Broadband Internet Access Services generate a prioritization list that is in part based on the billing profiles and a billing history (*e.g.*, prioritization will consider the specific plan, features, and/or previously paid data usage) for each of the devices.

The prioritization list defines an order for the plurality of devices accessing a shared network resource (*e.g.*, a cell tower or base station or backhaul link), based on the billing profiles and billing history for each of the plurality of devices. For example, on information and belief, AT&T generates a prioritization list to determine which, if any, device will see a decrease in data speed based on, in part, the plan associated with the device (which is part of the “billing profile”) and the amount and/or type of data transmitted under that plan for a particular billing period or whether a user has failed to pay amounts owed AT&T (which forms part of the billing history). On information and belief, whether a user’s device will experience decreased data speeds depends on, in part, the billing profile (*e.g.*, specific plan and the data usage for a particular billing period).

	<p>Implementing AT&amp;T's Broadband Internet Access Services requires generating a prioritization list that is in part based on the billing profiles and a billing history (<i>e.g.</i>, prioritization will consider the specific plan, features, and/or previously paid data usage) for each of the devices.</p> <p>AT&amp;T prioritizes certain user's traffic:</p> <ul style="list-style-type: none"> <li>• "Congestion-based Data Management. One network management practice we use to manage our wireless network resources <i>may affect customers with most AT&amp;T post-paid and AT&amp;T PREPAID<sup>SM</sup> unlimited mobile data plans</i> ("AT&amp;T Unlimited Data Plans"). During periods of congestion, these customers may experience reduced data speeds and increased latency as compared to other customers using the same cell site ("Congestion-based Data Management"). <i>Depending on the customer's AT&amp;T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&amp;T Unlimited Data Plan</i> (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&amp;T Unlimited Data Plans." (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> </ul> <p>This prioritization is based on the billing profile (<i>e.g.</i>, data plan) and billing history (<i>e.g.</i>, high speed usage during your billing cycle) associated with the device:</p> <ul style="list-style-type: none"> <li>• "<i>For customers on plans subject to a data usage threshold for triggering the foregoing congestion management practice</i>, we will notify them during each billing cycle when their usage reaches 75% of their threshold (so, for example, 16.5GB for plans with a 22GB threshold and 37.5GB for plans with a 50GB threshold) so they can adjust their usage to avoid network management practices that may result in slower data speeds." (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> <li>• "Congestion-based Data Management. One network management practice we use to manage our wireless network resources <i>may affect customers with most AT&amp;T post-paid and AT&amp;T PREPAID<sup>SM</sup> unlimited mobile data plans</i> ("AT&amp;T Unlimited Data Plans"). During periods of</li> </ul>
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congestion, these customers may experience reduced data speeds and increased latency as compared to other customers using the same cell site (“Congestion-based Data Management”). *Depending on the customer’s AT&T Unlimited Data Plan, they will either always experience Congestion-based Data Management or experience it only after they have used a set amount of data in a billing period as outlined in their AT&T Unlimited Data Plan* (for example, 22GB or 50GB of data in a billing period). As always, even when subject to this congestion management practice, these customers have the comfort of knowing that, no matter how much data they use in a billing cycle, they will never be subject to overage charges and will pay a single monthly flat rate. That is our essential promise with the AT&T Unlimited Data Plans.” (<https://about.att.com/sites/broadband/network>)

The screenshot displays three AT&T Unlimited Data Plans side-by-side. Each plan includes a list of features and a 'Get started' button at the bottom.

Plan Name	Price (per line)	Key Features
AT&T UNLIMITED ELITE® PLAN	\$50 /mo. per line (when you get 4 lines)	<ul style="list-style-type: none"> <li>Unlimited talk, text, &amp; high-speed data that can't slow down based on how much you use</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® advanced security (including spam &amp; fraud call blocking, identity monitoring, safe browsing, and more)</li> <li>40GB Hotspot data per line per month</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>4K UHD streaming available</li> <li>HBO Max™ included</li> <li>Stadia Pro—6 months of streaming gaming on us</li> <li>Signature Program members save up to \$10/mo. per line through your work or organization</li> </ul>
AT&T UNLIMITED EXTRA® PLAN	\$40 /mo. per line (when you get 4 lines)	<ul style="list-style-type: none"> <li>Unlimited talk, text, data + 50GB of Premium Data (After 50GB, AT&amp;T may temporarily slow data speeds if the network is busy)</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® advanced security (including spam &amp; fraud call blocking, identity monitoring, safe browsing, and more)</li> <li>15GB Hotspot data per line per month</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>Standard-definition streaming</li> <li>Stadia Pro—6 months of streaming gaming on us</li> </ul>
AT&T UNLIMITED STARTER® PLAN	\$35 /mo. per line (when you get 4 lines)	<ul style="list-style-type: none"> <li>Unlimited talk, text &amp; data (AT&amp;T may temporarily slow data speeds if the network is busy)</li> <li>5G access included</li> <li>AT&amp;T ActiveArmor® security (including spam &amp; fraud call blocking, and more)</li> <li>Unlimited talk, text and data in Mexico &amp; Canada (2G off net data speeds may apply)</li> <li>Unlimited texting from U.S. to 200+ countries</li> <li>Standard-definition streaming</li> <li>Stadia Pro—6 months of streaming gaming on us</li> </ul>

Get started

[Learn more about Unlimited Your Way™](#)

	<a href="https://www.att.com/plans/wireless/">https://www.att.com/plans/wireless/</a>
<b>37[D]</b> wherein said processor further configured to repeat:	Implementing AT&T's Broadband Internet Access Services repeats steps 37[E], 37[F], 37[G], and 37[H] below.
<b>37[E]</b> receiving traffic profiles over said network resource for said plurality of devices;	<i>See</i> limitation 10[E], which is incorporated here.
<b>37[F]</b> managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,	<i>See</i> limitation 10[F], which is incorporated here.
<b>37[G]</b> selecting at least one of said devices based on said prioritization list; and	<i>See</i> limitation 10[G] (describing selecting a device based on a prioritization list).
<b>37[H]</b> dynamically modifying said service profile for said selected devices, if said network resource is underutilized by communications corresponding to said traffic profiles or if said network resource would be over-utilized by	<p><i>See</i> limitation 18[J] (describing dynamically modifying the service profile by reducing a maximum guaranteed bit rate). Reducing a maximum guaranteed bit rate is an example of AT&amp;T's Broadband Internet Access Services modifying a restriction on communications for the at least one of said plurality of devices.</p> <p>Another example of AT&amp;T's Broadband Internet Access Services modifying a restriction on communications for the at least one of said plurality of devices is by reducing the typical speed of video streams during periods of congestion, which vary by plan, for video streaming. <i>See</i> limitation 23[A].</p>

communications corresponding to said traffic profiles wherein the dynamically modifying includes modifying a restriction on communications for the at least one of said plurality of devices;	
<b>37[I]</b> until said plurality of devices no longer continue to share said network resource; and	<i>See</i> limitation 10[H] (describing a similar limitation).
<b>37[J]</b> wherein said processor is further configured, when said plurality of devices are no longer sharing said network resource, to clear said prioritization list.	<i>See</i> limitation 10[I] (describing a similar limitation).

CLAIM 38	'813 PATENT V. AT&T
<p><b>38[A].</b> The apparatus of claim 37, wherein the restriction on communications is a guaranteed bit rate.</p>	<p><i>See</i> limitation 18[J] (describing dynamically modifying the service profile by reducing a maximum guaranteed bit rate). Reducing a maximum guaranteed bit rate is an example of AT&amp;T's Broadband Internet Access Services modifying a restriction on communications for the at least one of said plurality of devices.</p> <p>Implementing AT&amp;T's Broadband Internet Access Services can reduce a customer's maximum guaranteed bit rate by adjusting the data speeds when the resource is over utilized by the customer's data requests. This lower guaranteed bit rate is a restriction on communication.</p> <ul style="list-style-type: none"> <li>• In addition, <i>this network management practice adjusts dynamically to address the amount of congestion</i>, which can start and stop over a very short time period (often measured in fractions of a second), further minimizing any customer impact. Because the amount of congestion at a cell site can vary significantly, the performance impact for affected AT&amp;T Unlimited Data Plan customers may also vary significantly, but such impact will last only as long as the site is congested. (<a href="https://about.att.com/sites/broadband/network">https://about.att.com/sites/broadband/network</a>)</li> </ul> <p>AT&amp;T explains that it “may temporarily slow your speed at any time if our network is busy.” This intentional slowing is a reduction in the maximum guaranteed bit rate for a particular device.</p> <ul style="list-style-type: none"> <li>• “If a lot of devices are using mobile data at once, it can put a strain in our network. This is called network congestion, and we may have to slow your data speed to keep everyone connected. On an unlimited plan? <i>We may temporarily slow your speed at any time if our network is busy.</i> We may also slow it after you use more than 50GB or 22GB of data in a single bill period.” (<a href="https://www.att.com/help/wireless/data-usage/">https://www.att.com/help/wireless/data-usage/</a>)</li> </ul>

CLAIM 39	'813 PATENT V. AT&T
<b>39[A].</b> The apparatus of claim 37, wherein the network resource is one of a cellular base station or a backhaul link.	<i>See</i> limitation 19[A] (describing the network resource as base station) and limitation 20[A] (describing the network resource as a back-haul link), which are incorporated here.

CLAIM 40	'813 PATENT V. AT&T
<b>40[A].</b> The apparatus of claim 37, wherein the processor is configured to perform the dynamic modification only if said network resource would be over-utilized by said traffic profiles.	<i>See</i> limitation 26[A], which is incorporated here.

CLAIM 41	'813 PATENT V. AT&T
<b>41[A]</b> . A computer-implemented method for dynamic allocation of network resources comprising:	<i>See</i> limitation 18[A], which is incorporated here.
<b>41[B]</b> grouping, by a computing system that includes one or more cellular network elements, a plurality of computing devices sharing a cellular network resource;	<i>See</i> limitation 18[B], which is incorporated here.
<b>41[C]</b> receiving a service profile for each of the plurality of devices sharing the network resource;	<i>See</i> limitation 18[C], which is incorporated here.
<b>41[D]</b> receiving a billing profile for each of said plurality of devices;	<i>See</i> limitation 18[D], which is incorporated here.
<b>41[E]</b> generating a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing	<i>See</i> limitation 18[E], which is incorporated here.

history for each of said plurality of devices;	
<b>41[F]</b> repeating, by the computing system:	Implementing AT&T's Broadband Internet Access Services repeats, by the computing system, steps 41[G]-41[J] below.
<b>41[G]</b> receiving predetermined traffic profiles indicating attributes of current traffic activity over said network resource by said plurality of devices;	<i>See</i> limitation 18[G], which is incorporated here.
<b>41[H]</b> managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,	<i>See</i> limitation 18[H], which is incorporated here.
<b>41[I]</b> selecting at least one of said devices based on said prioritization list; and	<i>See</i> limitation 18[I], which is incorporated here.
<b>41[J]</b> dynamically modifying said service profile for the selected devices, if said network resource is under-utilized by said traffic profiles or if	<i>See</i> limitation 18[J], which is incorporated here.

said network resource would be over-utilized by said traffic profiles, wherein the dynamic modification includes automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to contention for the shared network resource;	
<b>41[K]</b> until said plurality of devices no longer continue to share said network resource; and	<i>See</i> limitation 18[K], which is incorporated here.
<b>41[L]</b> when said plurality of devices are no longer sharing said network resource, clearing said prioritization list.	<i>See</i> limitation 18[L], which is incorporated here.

CLAIM 42	'813 PATENT V. AT&T
<b>42[A]</b> . A computer-implemented method for dynamic allocation of network resources comprising:	<i>See</i> limitation 18[A], which is incorporated here.
<b>42[B]</b> grouping, by a computing system that includes one or more cellular network elements, a plurality of computing devices sharing a cellular network resource;	<i>See</i> limitation 18[B], which is incorporated here.
<b>42[C]</b> receiving a service profile for each of the plurality of devices sharing the network resource;	<i>See</i> limitation 18[C], which is incorporated here.
<b>42[D]</b> receiving a billing profile for each of said plurality of devices;	<i>See</i> limitation 18[D], which is incorporated here.
<b>42[E]</b> generating a prioritization list defining an order of said plurality of devices within the group, based on said billing profiles and on a billing	<i>See</i> limitation 18[E], which is incorporated here.

history for each of said plurality of devices;	
<b>42[F]</b> repeating, by the computing system:	Implementing AT&T's Broadband Internet Access Services repeats, by the computing system, steps 42[G]-42[J] below.
<b>42[G]</b> determining and receiving traffic profiles indicating attributes of current traffic activity over said network resource by said plurality of devices;	<i>See</i> limitation 18[G], which is incorporated here.
<b>42[H]</b> managing said network resource according to said service profile and said billing profile if said network resource is fully utilized by said traffic profiles; and,	<i>See</i> limitation 18[H], which is incorporated here.
<b>42[I]</b> selecting at least one of said devices based on said prioritization list; and	<i>See</i> limitation 18[I], which is incorporated here.
<b>42[J]</b> dynamically modifying at least one of said service profile and said billing profile for the selected devices, if said network resource is under-utilized by said traffic	<i>See</i> limitation 18[J] (describing AT&T's Broadband Internet Access Services dynamically modifying a service profile by reducing a maximum guaranteed bit rate), which is incorporated here.

profiles or if said network resource would be over-utilized by said traffic profiles, wherein the dynamic modification includes automatically reducing a maximum guaranteed bit rate to a lower guaranteed bit rate in response to contention for the shared network resource;	
<b>42[K]</b> until said plurality of devices no longer continue to share said network resource; and	<i>See</i> limitation 18[K], which is incorporated here.
<b>42[L]</b> when said plurality of devices are no longer sharing said network resource, clearing said prioritization list.	<i>See</i> limitation 18[L], which is incorporated here.